ESTONIAN UNIVERSITY OF LIFE SCIENCES

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TOIDUJÄÄTMETE VÄHENDAMISE VÕIMALIK MÕJU KAUBANDUSBILANSILE: EESTI JUHTUMIUURING

FOOD WASTE REDUCTION AND ITS POTENTIAL IMPACT ON TRADE BALANCE – A CASE STUDY OF ESTONIA

Master's thesis

Curriculum Agri-Food Business Management

Supervisor: Ants-Hannes Viira, *Ph. D*

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In view of the global challenge of food security and scarcity of natural resources, the phenomena of food losses and wastes have been given serious attention in past few years. With the view of its implication to society, environment and economy, the food wastes reduction has been greatly emphasized by United Nations and European Union in their strategies. This exploratory study establishes a relationship among food losses at primary agriculture stage of food life cycle and its impact on trade balance. Though, the economic assessment of losses has necessary condition of quantification of such lost amount which has already been done in Estonia. The aim of this study is generally the verification of probability that excluding such losses would result in imports savings and exports gains and resultant improvement in agriculture trade balance. Methodological approach based on literature analysis and quantitative assessment where potentially avoidable losses estimation has been done to compare with trade data of selected commodities. It has been empirically proven that excluding losses has huge economic and financial benefits and has various socio-economic implications both at micro and macro level. The management of losses requires structural assessment of those drivers and system pressures that triggers and causes those losses, the corresponding management options depends on nature of those losses.

Keywords: Food losses, Food wastes, Food Supply Chain, Trade balance, Imports, Exports

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Toiduga kindlustatuse ja loodusvarade nappuse ülemaailmset väljakutset silmas pidades on toidu kadudele ja raiskamisele viimastel aastatel tõsist tähelepanu pööratud. Pidades silmas selle mõju ühiskonnale, keskkonnale ja majandusele, on ÜRO ja Euroopa Liit oma strateegiates rõhutanud toidujäätmete vähendamise vajadust. Selles magistritöös selgitatakse välja seos toiduainete elutsükli esmases ehk põllumajanduse etapis tekkiva toidukao ja kaubandusbilansi vahel. Majandusliku hindamise eelduseks on toidukao koguse hindamine, mida on Eestis juba tehtud. Selle uuringu eesmärk on kontrollida eeldust, et kadude vähendamine tooks kaasa impordi vähenemise ja ekspordi kasvu ning sellest tulenevalt põllumajanduse väliskaubandusbilansi paranemise. Uuringus kasutatakse kirjanduse analüüsil ja kvantitatiivsel analüüsil põhinevat metoodilist lähenemist. Hinnatakse potentsiaalselt välditavaid kadusid ja võrreldakse neid valitud kaupade väliskaubanduse andmetega. On empiiriliselt tõestatud, et kadude vähendamisega kaasneb on oluline majanduslik ja rahaline kasu ning sellel on mitmesuguseid sotsiaal-majanduslikke tagajärgi nii mikro- kui ka makrotasandil. Kadude vähendamine nõuab nende tegurite ja süsteemi struktuuri hindamist, mis neid kadusid põhjustavad, vastavad juhtimislahendusedsõltuvad kahjude laadist.

Märksõnad: Toidukaod, Toidujäätmed, Toidu tarneahel, Väliskaubandusbilanss, Import, Eksport

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INTRODUCTION

The world has been facing continuous population growth that will reach roughly about nine billion by the middle of this century, putting persistent and unavoidable pressure on natural resources. The increasing demand for food to feed the foreseen population growth and ensure uninterrupted food supply more efficiently and equitably around the globe is the most complex challenge to tackle. In view of limited resources, harsh climate changes require a careful assessment of this challenge to help reduce the further pressure on natural resources and improve biodiversity (Godfray et al. 2010). Moreover, the existing pattern of exploitation of natural resources to fulfil the human demand is perhaps the major reason for environmental degradation and absolutely a great threat to long term food security (Garacia et al. 2018). Hence, to meet the existing demand without compromising the state of natural resources is the need of the hour.

Several possible solutions to address the issue have been proposed and considered in different time periods. One amongst many has been the careful improvement in agriculture production practices that needs to be sustainable and least harmful for ecosystem. Another view have been highly supportive to encourage the people for changing their dietary habits but this seems more or less ineffective in presence of personal choices and income rise that does not stop the vulnerable change in demand patterns. Some other measures that include demand side restrictions, were also examined and implemented to improve and control situation. Yet, reduction in food waste in supply chain is the most important phenomena (Alexander et al. 2017). Food losses implies to infrastructural and knowledge improvements, that are unconscious part of losses and are unavoidably generated by system. Whereas, food waste is behavioral issue that occurs because of negligence or conscious act of throwing food away (Kowalska, 2017).

Therefore, the food losses and waste reduction are fundamental aspect on which there have been consensus among the scientists, researchers and policy makers, that could potentially address the on-going issue of food security, and resultant economic benefits and preservation of natural resources (Chabourd and Daviron, 2017). Further, the efficiency of food supply chain requires incredible reduction in food losses (Foresight, 2011).

The global challenge of food security has been assessed and several policy action and initiative has been taken to overcome and reduce this issue. Such as in 2015, the United Nations' Sustainable Development Goals out of which one addressing "sustainable production and consumption patterns" includes the agendas of food waste reduction by 2030. (UN, 2015)

The similar target has been set in European Circular Economy Action Plan, and in order to ensure uniform policy a "revised waste Framework Directive" have been adopted since 2018. It requires the EU member states to prepare the individual food waste prevention program at national level. Moreover, at legislation level it requires the member states to spread awareness of food loss by implementation of general food law. Separate legislation implemented in March 2019 requests the member states to make legislation on food waste measurement. By and large proposal for 2023 is to set up the requirement for food waste regulations target. (European Commission, 2018).

Another point worth mentioning here is that, ratio of food wastage is not same around the globe. The rate of food waste in high income countries is six times greater than in low-income countries. So is the impact on environment that is 10 times more severe in high income countries compare to low-income countries. (Chen et al. 2020)

The concept of food waste has been extensively discussed in literature with its implication to serval social, ethical, environmental and economic dimensions. For instance, Ribeiro et al. (2018) highlight the social aspects for these food losses generated on the different stages of the supply chain (primary production, processing, retail, distribution and consumption), emphasizing on the social motive of donation to prevent and lesson the social effects. Whereas, Griffin et al. (2009) highlight the environmental aspects of this issue. Yet, this master thesis is focused on the economic impact of food wastage with specifically taking the dimension of trade balance; import export balance of primary agriculture of Estonia. The complexity of supply chain and non-availability of data at different stages, makes it even hard to exactly estimates of these losses and their impact on trade balance (Parfitt et al. 2010).

Estonia has been self-sufficient in provision of food to entire population since last century (Põldaru et al. 2018). Yet, unsuitable climate for growers calls for a careful use of available food supply. The quantification of food losses has been undergoing and only the primary food losses has been quantified so far. SEI Tallinn established that Estonian residents waste almost 63 million euros each year based on the survey conducted in 2015 (Värnik et al.

2021). Therefore, preventive measures in food wastage could be beneficial from economical point of view.

According to statistics Estonia, the primary agriculture share to GDP is 2.2 % in 2020 (Statistics Estonia, RAA0042) that is nominal yet considerable to feed 1.3 million of population. Nevertheless, the agricultural products and by products have been the significant contributors to net foreign exchange earnings as well as the costs. Only the primary agriculture accounted exports of worth 1174 million euros while the imports are 1507 million euros in 2020 (European Commission, 2021). Current agriculture data analysis reflects negative trade balance, making overall balance of trade to remain negative, worth 19.6 million euro in first quarter of 2020 (Statistics Estonia, 2020). Leading analysts consider that the driving force behind economic down turn is the contraction of primary agriculture, fishery and forestry along with the other sectors (ERR, 2021). The above-mentioned analysis provides a strong evidence and rational for mitigation of the huge food losses and for the careful use of existing supply that would in turn sufficiently improve the trade balance and earnings as well.

In open economy, not only the income, prices, tariff and subsidies determine imports and exports, yet various other factors contribute to attain and improve such balance (Khan et al. 2010). For instance, rational use of available produce can potentially impact the quantity demand for imports of such products. In context of agri-food products with perishable nature make them sensitive to be traded to far-off regions but absence of local produce makes it essential too (Sarker et al. 2007). With regard to the topic under consideration, reduction in available food losses in each stage of supply chain will surely improve the quantity supplied for consumption. Therefore, in presence of fixed local demand at least for current time period, in short run, this excess supply with either reduce imports or in turn create the value through exports.

Hence, aim of this thesis is to evaluate the impact of losses in primary production and processing on overall imports and exports of primary agriculture of Estonia.

The following research tasks have been considered for the sake of this work;

1. To provide the definition of food loss and wastes from literature and to present the fundamental analysis of its categorization throughout the supply chain.
2. To understand the primary agriculture resources of Estonia.

3. To analyze the wastage in primary production in Estonia and existing trade balance by considering only the primary agriculture of Estonia.
4. To establish a relationship between food losses and primary agriculture balance of trade and to evaluate the possible effect of food losses on import /export of agriculture of Estonia.
5. To highlight the management aspect of food losses in primary supply chain and possible approaches to tackle the issues.

The scope of this work is only confined to the primary production, primary processes, storage, transportation and primary processing losses and their possible impact on trade balance (import, export) of Estonia in 2020. Four commodities (wheat, milk, potatoes and strawberries) have been chosen from entire food basket for such analysis. The losses data related to these commodities have been published previously, establishing a reason to analyze the relative effects on trade of these commodities.

Methodology is mainly based on descriptive approach, literature analysis and calculations in which the quantity of avoidable food losses of four commodities will be compared with the overall production to find possible additional supply. Further, the trade effect will be accounted, presuming the nature of effect of additional supply on imports or exports of these commodities. The financial assessment will be made based on market prices of these commodities to find the potential imports savings and exports gains. Finally, this data will be analyzed to import and export volume of these products (both in terms of quantity and finance) to find the actual possible improvement in balance of trade.

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1. GENERAL CONCEPT OF FOOD LOSSES/WASTES AND RELATED POLICIES

1.1 Background information

The world population has been growing at the rapid pace, according to united nations department of Economic and Social Affairs, projected to be around 9.5 billion in 2050. The annual addition to global population will be around 34 million persons. This immense population rise that would be termed as "population explosion" is no doubt, unsustainably large. The notion of uprising trend in population growth is true for all regions and around the globe, threatens the sustainable existence of mankind on earth. (Berry et al. 2015).

The ongoing rise in demand, posing a serious threat on availability of resources for all human beings according to their needs. (Bruinsma, 2003. pg:5). Paul et al. (1971) has regarded this old aged issue of mankind as "storm of crises" leading to various sociological, economic and ecological issues. The most crucial implication of this matter has been analyzed in case of resource supply to individuals. Specially, to feed everyone according to need. Hence, the possible expansion in existing food supply till 2050 has been under consideration. Apparently, the human race has already pushed the productive limits and capacities of natural resources to their extreme edge. Further, the ecological and biological system has already been depleting. (Buringh, 2017).

Nevertheless, the extension in food supply has been enormously constrained because of fast depleting fossil fuels and natural resources and subsequent carbon emission. (Just et al. 2005). The resources have considerably high marginal recovery cost. The human activity has strong connection with exploitation of resources. According to Hook et al. (2010), the resource replenishment is far more less than its depletion. The extensive agriculture practices for utilizing it to its potential and subsequent deforestation causes ecological imbalance, soil erosion and contamination of resources. (Ali et al. 2021).

Several solutions have been proposed and implemented to avoid these ecological factors and to meet the requirement of population at the same time. One amongst other, has been the extensive agriculture methods, alternative land use for irrigation, agro- forestry, specifically the use of fertilizers remained common among developing countries. (Liu et al. 2021).

Further, the changes in dietary structure (plant based to animal based) put more pressure on water resources as animal being source of food requires more resources to grow. But this

demand restriction seems unavoidable in presence of growing incomes and preferences. (Tian, 2021). Therefore, the demand and supply side analysis, makes the fact more evident that growing population requires 70 to 100 percent increase in production of food crops that may not be possible.

Hence, the most logical solution requires a careful assessment of existing resources to be used in rational way. Avoiding losses and wastes throughout the supply chain of food, from field to consumers. As estimation made by the United Nations department of economic affairs, 1.3 billion tons of food is being lost each year globally. (Aulakh et al. 2013). This lost account for one third of food that was cultivated for human use. Reflecting food loss as the major and most challenging issue of globe. (Garcia et al. 2017)

1.2 Countries initiatives on food loses and wastes

According to an estimation, 800 million people around the globe are suffering from hunger. Yet, paradoxically one third of global food is lost that could be sufficient enough to feed 12% of population. (Gracia et al. 2019). Despite being emphasized on increased productivity for food security, the attention has been shifted on sustainable/ rational use of existing food supply. As discussed earlier, the nature of this phenomena is different among high- and low-income countries, so as their causes and effects. In rich countries for instance, these losses more likely to generate at the end of supply chain while in low-income countries with poor technology, this ratio is considerably high in start of supply chain at the post-harvest stages and production level. (Chen et al. 2021).

For instance, in case of China, representing 20% of world population with 7% arable land (Larson, 2013), pattern of food wastes throughout the supply chain has been poorly understood. Only fragmented databased on informed estimates is available and its rarely complete. Though Chania's progress to infrastructural changes comes up with reduces post-harvest losses, till the date the concept of food losses could not generally be identified separate to municipal waste. Although food losses comprise 50 to 70 percent of municipal wastes in China. (Tia et al. 2011). At legislation level, lacking official data leads to not many policies/ regulations but few implemented policies taking food generation and treatment separately. (Liu, 2014). Recently, relationship of food wastes treatment to economic growth has been realized. (Chen et al. 2021).

On the other hand, USA in presence of unified public policy and private actions for mitigation of food losses still realizing huge wastes, comprising estimated 31% of food

produced for consumption. (Walia, 2017). Presently,15 % potential food waste recovery has been estimated, sufficient enough to feed 18.45 million individuals in USA. (Godfray et al. 2010). In EU member states, following common EU regulations, quantification of losses has been undergoing. Overall, according to EU agenda for member states public awareness on the issue has been largely emphasized. (Campoy et al. 2017).

All facts considered, however, the evidence from different countries validates the fundamental acknowledgement of issue by the policy and stakeholders. Proving strong bases for policy shift from increased production to rational use of resources.

1.3 Implication of the concept at policy level

Food losses and wastes has emerged as priority agenda at national as well as global level. The United Nations has defined Sustainable Development goals, out of which target 12.3 is discussing the food waste issue. This requires the member states to halves per capita food wastes at retail and consumer level by 2030. Moreover, it is required to reduce food losses along production and supply chains. (UN, 2013)

In fact, a good understanding about the concept of food wastes and losses is no doubt, fundamental for reduction targets as well as for progress tracking. Exploration of mitigation strategy is also very much dependent on accurate quantification of data. (Lue et al. 2017). So, in response to Sustainable Development goals by UN, European Commission is tackling the issue of food wastes and losses on serious grounds. There has been a strong realization that food waste has undeniable potential to reduce consumable resources. Being efficient would be a great way to save food for human consumption, for saving money and reducing the subsequent environmental impacts (European Commission 2021).

In 2020, progress assessment to present food losses and food waste has been made by the German presidency to the European Union council. The main agenda revolves around settled milestones achieved at EU level. A careful assessment has been made regarding the progress made by the member states, including the development of strategies at national level and corresponding legislative and non- legislative initiatives. Furthermore, consumer awareness campaign were also emphases to be done by member states.

As a part of European Green Deal, A Farm to Fork strategy of EU is mainly concerned to set up actions that prevent food losses. As integral part of policy, several actions have been proposed.

- First, by end of 2022, date marking on products will be revised to ensure less wastage.
- Second, by end of 2023, achievement of food loss reduction level to baseline of EU food waste level.

Further the Farm to Fork Strategy will investigate and explore the ways to prevent food losses at each production stage. A persistent mobilization of players involved on food supply chain is also part of agenda to reduce wastes (European Commission, 2021).

In general, the problem of food loss and waste has been discussed in an interdisciplinary context for several years, from which numerous initiatives have emerged. Nevertheless, First Circular Economy Action Plan, implemented in 2015, aligns its agenda with steps taken to prevent food losses and wastes. The revised EU wastes legislation has been adopted on 30th May 2018, that requires the EU member states to take actions for reduced food wastes on each and every step of food supply chain. Continuous monitoring and reporting have been emphasized (Directive EU 2018).

Another, improvement towards implementation of practical steps is introduction of elaborated ways for adoption of common methodology to measure food waste under the Circular Economy Action Plan. This initiative also includes the facilitation of food donations, use of food when it is no more important to use by the humans (Directive EU 2018).

Through the EU Platform on Food Losses and Food Waste, the Commission is analyzing in close cooperation with industry, consumer and other NGOs, research institutes and EU countries policy experts how to reduce food waste without compromising food safety, while also discussing options for possible EU actions. Prior to the establishment of the EU Platform, cooperation had been facilitated through the EU countries Expert Group and a stakeholder Working Group on Food Losses and Food Waste.

1.4 Critical analysis of definitions, assessment approach and measurement unit of food losses/wastes

Although, there have been a lack of consensus on common definition and measurement ways of food losses, yet, a few approaches identified to understand the core concept. Accordingly, food wastes and losses are defined as separate terms in view of life cycle approach taking into account the pre- consumption and consumption stages. (Parfitt et al. 2010).

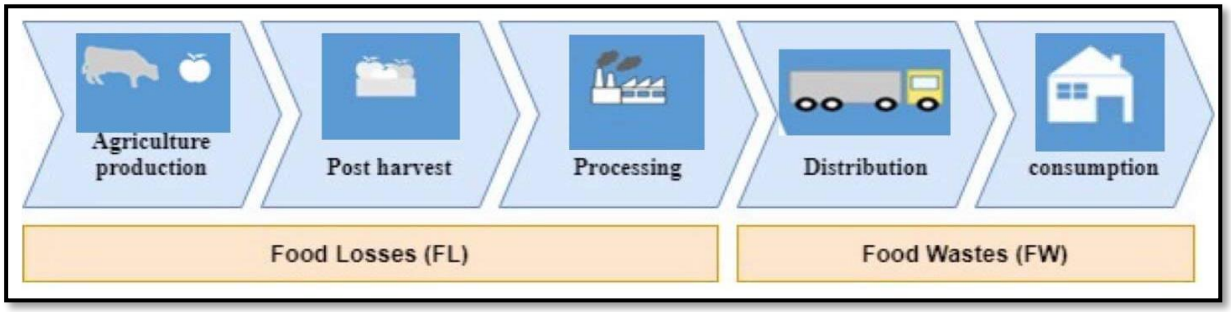

Figure 1 . Life cycle approach of defining food losses and wastes (Source: Garcia et al. 2018; Parfitt et al. 2010)

The most comprehensive definition of food losses and wastes have been presented by FAO in 2018, taking into account the reasons of potential losses and wastes they define "Food losses" that are mainly caused by inefficiencies in the food value chains, such as poor infrastructure and logistics, lack of technology, insufficient skills, knowledge and management capacity of value chain actors, and lack of access to markets. In addition, natural disasters play a role. While on the other side "Food wastes", refers to the removal of food from the food supply chain, which is fit for consumption, by choice, or which has been left to spoil or expire as a result of negligence by the actors.

Different writers have varied opinion on defining these terms, reflecting some similarities and differences among each other. For instance, Gustavsson et al. (2011), describe Food losses by categorizing it into avoidable, un avoidable and potentially avoidable losses, contrasting the view of Aulakh et al. (2013), who confined the losses as unavoidable and that occurs at the initial stage of life cycle.

Kowalska, 2017, defines food losses, exhibiting similarities with FAO approach, considering reasons of those losses described by FAO, Kowalska, taking a step forward, highlights the main issues for defining food losses, according to him Food losses implies to infrastructural and knowledge improvements, unconscious part of losses is unavoidable generated by system. The similar argument has been found in Aulakh et al. (2013) definition that has used the word of managerial limits of procedures as reasons of losses. (See appendix 1)

On the other side, writers are agreed over few characteristics defining the term of food wastes, for example, all consider the food wastes generated at the of food value chain, mainly at retails and final consumption stages. Main causes are wasteful behavior, a human action, that led to the non-utilization of food before even the food gets expired or throwing it

intentionally without taking any benefit from it. (Gustavsson et al.2011; Aulakh et al. 2013; Kowalska, 2017; Aragie et al. 2018)

All views considered, however, food losses and wastes probably lacking consensus in exact definition because of overlaps of fundamental facts that define these terms. For instance, the higher degree of wasteful behavior that used to define "wastes" in particular, could also be observed at initial stages of life cycle, gives a valid reason not to consider it losses but wastes only.

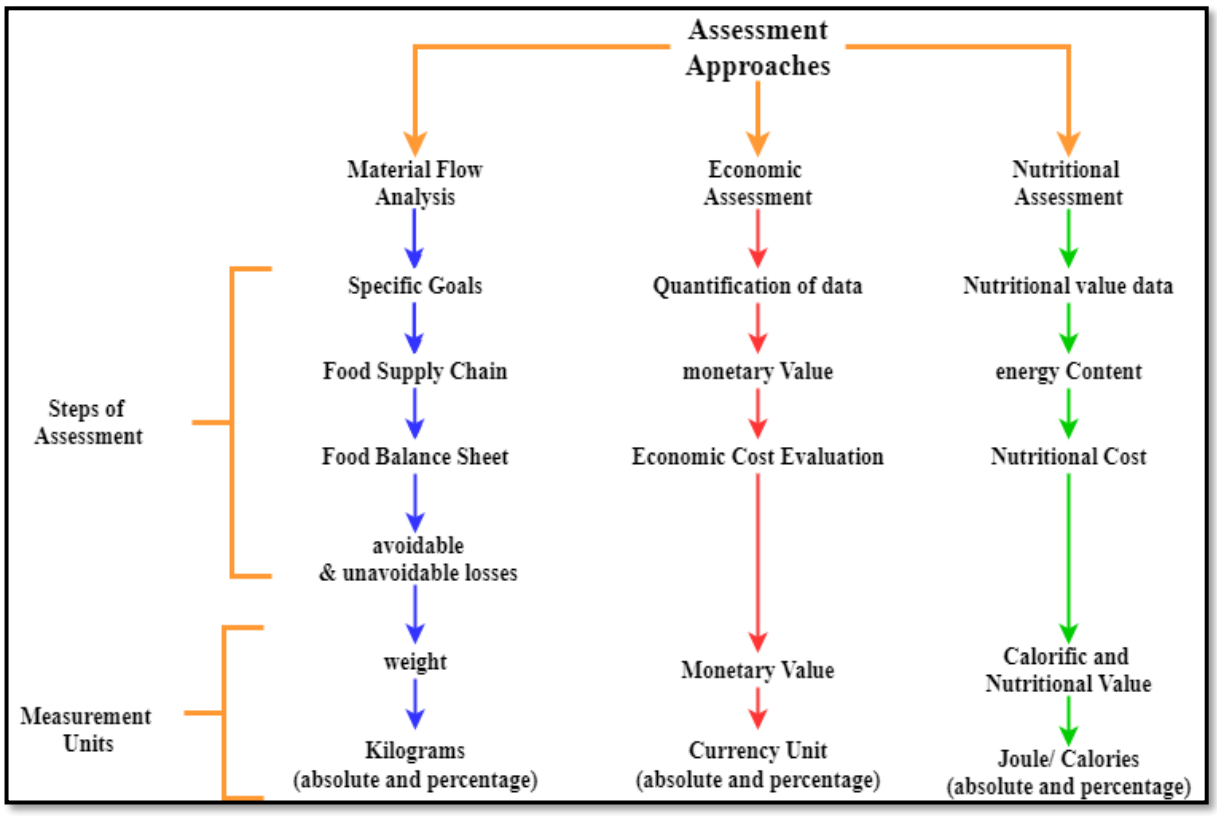

Figure 2. Assessment approaches and measurement unit of food losses/wastes (Source: Garcia et al. 2018 and Liu, 2014)

There are three fundamental approaches used for assessment of losses/ wastes in entire food life cycle so as the measurement units based on these assessment methods are shown in the figure 2. This study is confined to the economic assessment, where quantified data of losses/ wastes used for financial valuation to determine economic cost of these losses. Compared to material flow analysis where, the whole food supply chain is assessed based on goals defined for study, a food balance sheet is made to further separate avoidable losses from those that could not be avoided.

1.5 Dimensions of the concept of food losses

As describe earlier, one third of total food produced for human consumption has been wasted. Yet, this ratio of waste is quite different among high income to low-income countries. In rich countries, for instance, only the households account for half of total food wastes. Further, there are several social factors, behavioral aspects and demographic characteristics that are involved in this. (Stancu et al. 2016). Food wastes attributes to negative social impact as it accounts for shortage of available food resources that could be used and beneficial either. (Kummu et al. 2012).

The social aspect of food wastes includes the food security and reduction in physical availability of food to all the people according to their fundamental requirements. Moreover, equal provision and distribution of food among people. Yet, consumer behavior is the most considerable phenomena to be regarded when discussing social aspects of food wastes. (Kotykova et al. 2019).

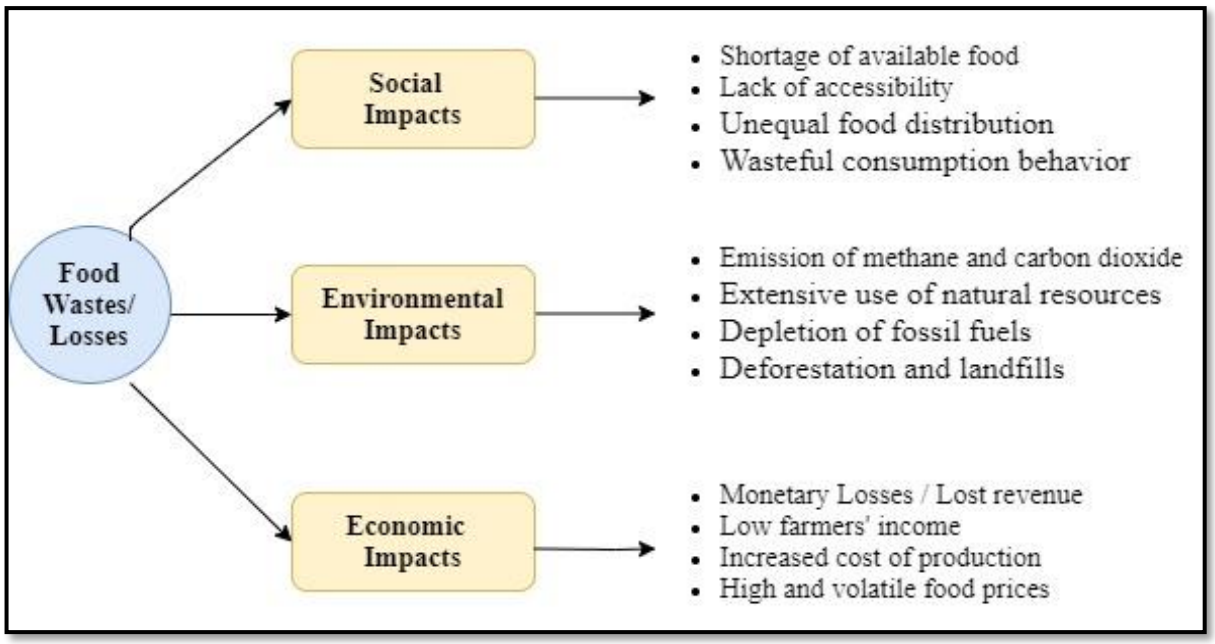

Figure 3. Dimensions of the concept of food losses (Source: Kummu et al. 2012, Kotykova et al. 2019, Lambin and Meyfroidt, 2011)

There is no denying the fact, that the food waste issue is significant. On one side, with the view of food security and on the other side with environmental impact and efficient resource utilization. Food wastes, by and large associated with huge emission of greenhouse gases.

The waste of natural resources deployed in production of food mainly include water, cropland and fossil fuels (Kummu et al. 2012).

Another environment impact is deforestation, as the more emphasis is being paid on increasing cropland for more food production. (Lambin and Meyfroidt, 2011). Therefore, over the past few years, food waste issue has gained attention of environmental associ1ations. Further, food waste is one type of land fill that no doubt, has negative impact on global climate change. (Nishida, 2014). Other phenomena are over production of food because of losses, this, for sure accounts for excessive use of natural resources and fossil fuels. Nevertheless, food landfills are great source of harmful gasses emission like methane and carbon dioxide. (Hall et al. 2009).

Economic effects include lost revenue and notion of rational use of resources, savings in terms of monetary value of these food losses. On primary level, avoiding these losses can lead to effect the economic benefits of those farmers and may be a source of improving the farmer gains. (Kotykova et al. 2019). As regard to costs of these food wastes the most monetary losses could be in value-added products. Empirically proven that such wastes cause the significant economic damage and lost monetary returns.

Although, so far, the major attentions have been on environmental impact of issue yet recently a shift has been seen towards economic consideration where monetary estimation of these losses are given more attention.

1.6 Food waste categorization throughout supply chain

1.6.1 General framework for categorization of food losses/wastes

Infect, food losses and wastes ae generated at the different stages of the food life cycle. There has been a lack of evidence base data, even the actual food waste quantification is on its infant stage. (Beretta et al. 2013). Hence, there are certain approaches that have been identified to categorize these losses/ waste. Some are based on moral views, whereas, the other define the functional perspective. (Liu, 2014). Figure 4 represents the comprehensive view of categorizing food losses and wastes.

The life cycle approach, takes into account the whole supply chain by distinguishing pre consumption stage of food from that of consumption stage, separating them as losses and wastes. Considering technological and managerial conception of these losses, it could further divide into farm level losses that occurs at pre-harvest stage and post-harvest losses that

mainly caused because of poor handling of yield. Moreover, these losses include the processing stage in which the material is being treated and refined for human consumption. (Liu, 2014).

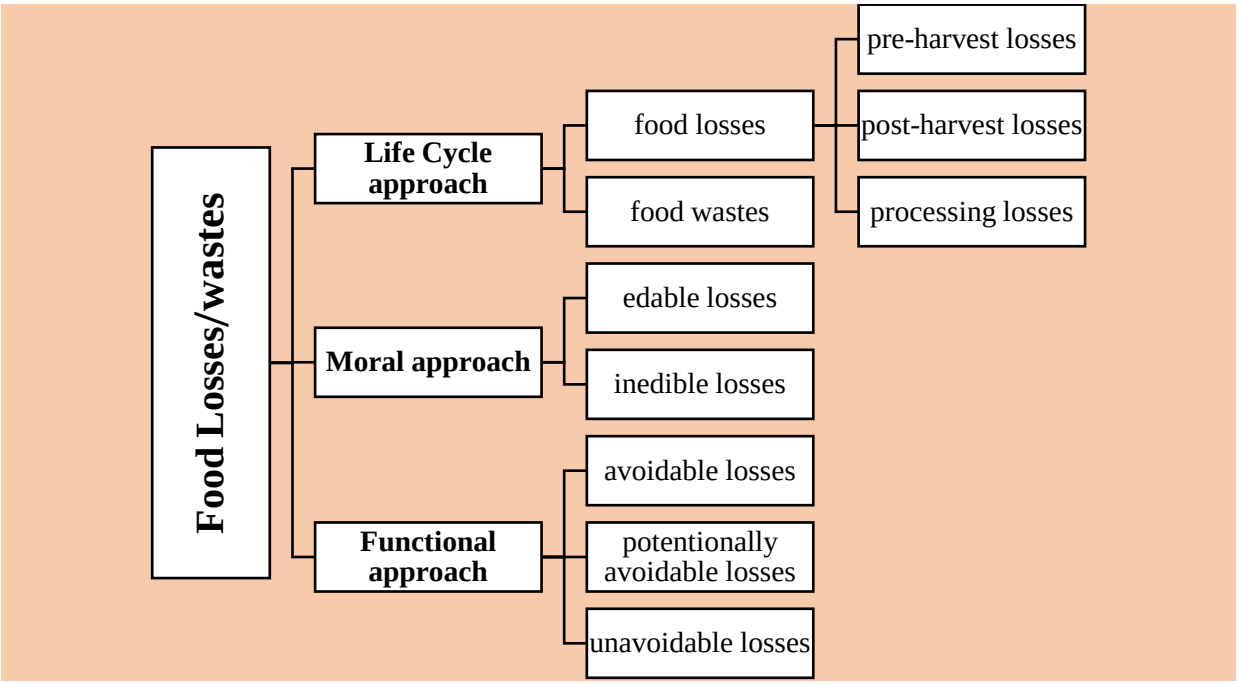

Figure 4. General framework of food waste categorization (Source: Parfitt et al. 2010; Liu, 2014; Beretta et al. 2013; Gustavsson et al.2011)

On the other side, moral approach attributes these losses in food supply chain according to the nature of consumption, separating edible food from that of inedible parts. The losses occurred in edible products are considered as the behavioral elements, whereas the inedible parts go for the livestock feed accounts. (Parfitt et al. 2010)

Beretta et al. 2013; Parfitt et al. 2010 and Gustavsson et al. 2011 categorizes food losses as avoidable, unavoidable and possibly avoidable losses. According to writers, the perishable products could be used before its expiration or before the product losses its natural state in that case the damaged or loss is avoidable because of intentional efforts made by the human. Possibly avoidable losses means that the state of product is acceptable for one segment of customers while not acceptable for others so in that case, losses are avoidable when product is used by the group of customers for whom it is acceptable. Whereas, unavoidable losses represent the complete damaged or spoilage of certain product.

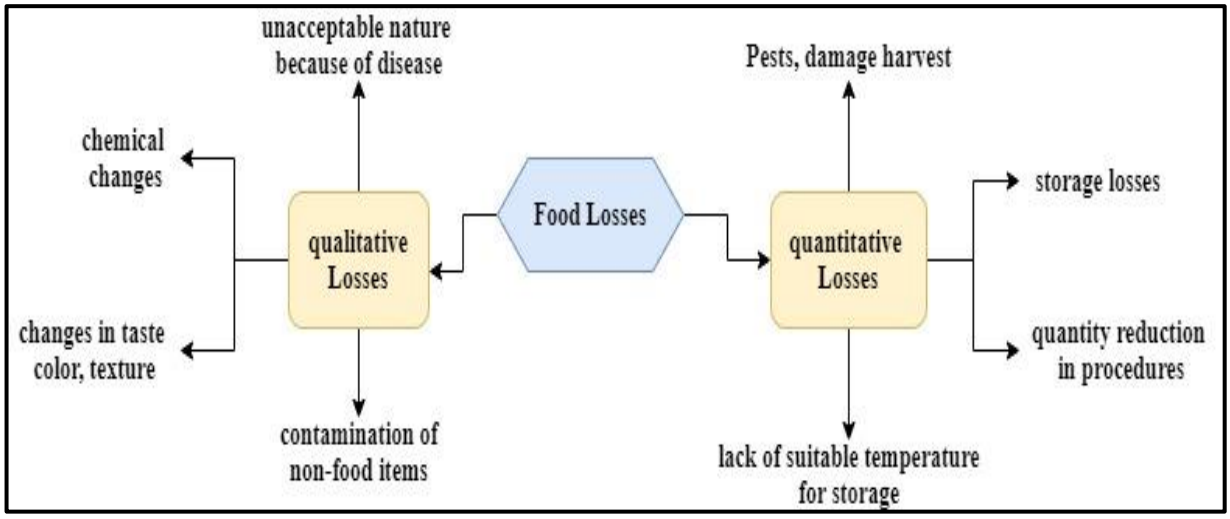

Figure 5. Food losses accoring to nature /state of product (Source: Aulskh et al. 2013)

Aulskh et al. 2013, further discussed the food losses, that could be both quantitative as well as qualitative in nature. For instance, the quantitative losses are mainly because of pests, damage harvests and stored grains. It could possibility be a quantitative loss during procedure results in quantity reduction. Further, the quantity loss may also occur because of changes in suitable temperature required for storage. Whereas, the qualitative losses represent the unacceptable nature of product due to spoilage, pests and diseases. It also caused by chemical changes that happens due to temperature fluctuations during storage. Moreover, it represents the contamination of food with non-food items or materials. Another situation is where these qualitative losses occur because of changes in tastes, texture, color of the food.

1.6.2 Flow analysis of entire supply chain losses

Although, the whole food supply chain is subject to degradation in one way or the other, unlike the other commodities that do not have perishable nature. Yet, the extent to which these losses generate across the entire food cycle varies among developing countries, the countries in transitional phase and those of high-income countries. (Parfitt et al. 2010). For instance, Chen et al. (2020) states the rate of food wastes in high income countries are six times greater than low-income countries. Further, in developed countries these losses generate at end of supply chain.

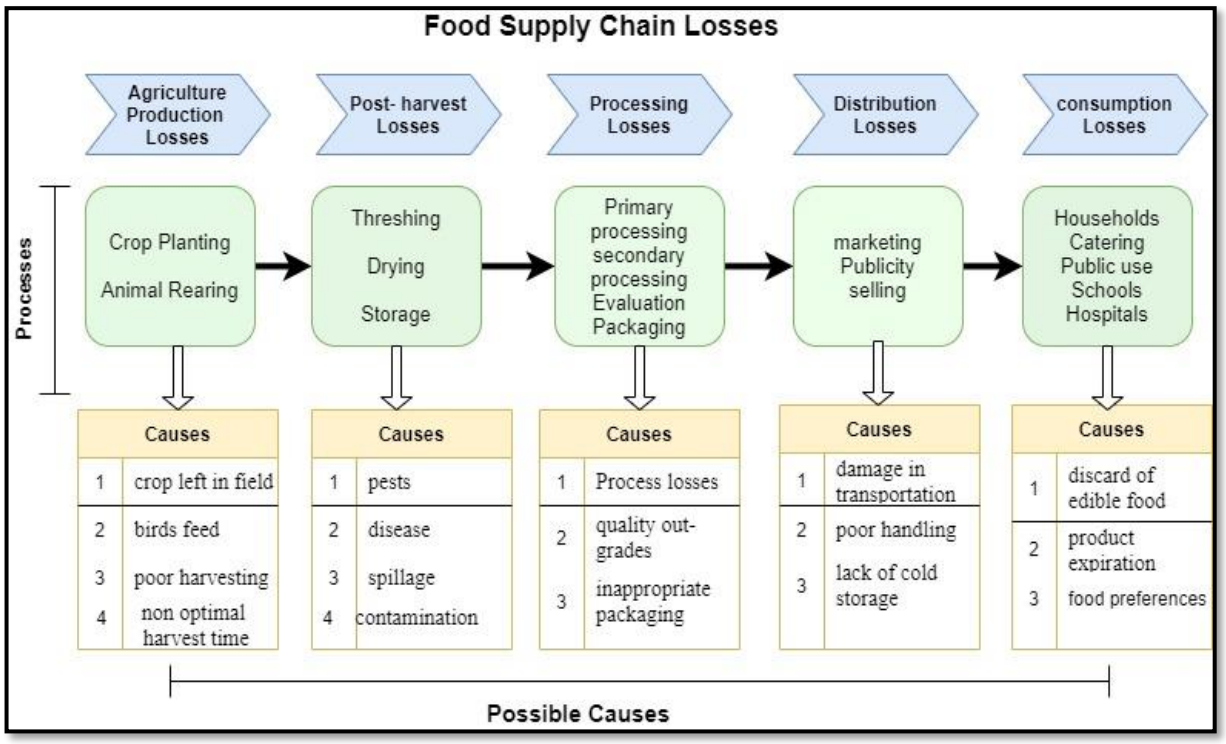

Figure 6 . Flow analysis of supply chain losses/ wastes (Source: Liu, 2014 and Parfitt et al. 2010; Alexander et al.2017)

Figure 6 represents the generic of whole food chain and various types of losses caused on each stage. Initiating at agriculture production stage (crop planting and animals' production), the main losses are characterized by handling at harvest, where edible crops are left in the field, some are ploughed into soil, a part of food becomes birds feed. Moreover, some technical and managerial aspects become evident at this stage including the neglection of optimal time of harvest and lack of efficient techniques of harvesting is the most prominent in all. (Parfitt et al. 2010).

In post-harvest stage, losses are generated at threshing, drying, transportation as well as distribution to the processing units. Mainly, losses owing to spoilage and brushing. At this stage storage requirement must be sufficient enough to avoid pests, diseases, spillage and contamination. In developing countries natural drying out process of food before storage causes major losses. (Lipinski et al. 2013)

Post-harvest stage is followed by processing in which the producers and processing companies are involved as the main actor of supply chain. General procedure involves the primary processing (cleaning, sorting, de-hulling, pounding, grinding, soaking, winnowing, drying, sieving and milling). In advance units secondary processing (mixing, cooking,

frying, molding, cutting and extrusion) caused losses when product upgraded/ discarded because of quality loss. Further, in processing units product quality is controlled by following standard, any deviation from standard caused the rejection of produced material. Similarly, in case of packaging, where these companies maintain strict weighting, labelling and selling standards. Inappropriate packaging, spillage from sacks or wrong labeling caused losses. (Corallo et al. 2018).

In food supply chain, marketing activities are characterized by distribution to both wholesalers and retails, hereby, the losses occurred by the product not meeting esthetic requirements, poor order forecasting, demand estimates and when the product is not sold till 'best date of use'. (Lipinski et al. 2013). During marketing and distribution, product cooling and storage at appropriate temperature is also the important factor to avoid losses. Nevertheless, the consumer/household also caused degradation of edible food, poor storage, stock management and discard of edible food before serving. Moreover, discarding edible food with non-edible because of food preferences are one reason in many. (Parfitt et al. 2010).

Flow analysis reflects the main causes of losses and wastes in general, yet, it never includes the byproducts (skin, seeds, peels etc.), that is unavoidable food waste, not intended for human consumption. Further, the phenomena of surplus food directed to food stocks and food banks, food grown intentionally for feed and factors like overconsumption (more than required nutrients) are not been considered.

2. ESTONIAN FOOD LOSSES, MANAGEMENT AND TRADE BALANCE

2.1 Introduction to main resources of primary agriculture and food supply chain of Estonia

2.1.1 Main agriculture resources of Estonia

Estonia restored independence in 1991 and Soviet Collective Farms were either privatized or closed, given an open opportunity for small farms and associations. Yet, it is proved to be quite hard for the small farmers to compete with the cheap imported products. Accession to EU has made possible for such farmers to access to European markets. Further, various support schemes of EU's CAP played vital role in stimulated the agriculture land use in Estonia. (Poldaru et al. 2018). Now a days, big associations accounts for the major share in agriculture. (Statistics Estonia)

The demographic distribution of population among rural and urban regions reflects an imbalance of 39% and 61% respectively (Statistics Estonia, RV0219U, 2020). But agriculture being sector remained lower in potential labor force, contributing merely 3.1% in total employment in year 2020. According to European Commission, Eurostat and Directorate General of Rural Development 48.7% of CAP expenditures directly goes for rural development plans, providing support to the sector. The contextual indicators of Estonia and Estonian agriculture sector in June 2020 are given in appendix 2, that helps understand the structure of agriculture to overall economy.

The main cultivation in Estonia includes field crops such as cereal crops, industrial crops, vegetables and horticultural products, potatoes, fruits especially, strawberries and some plant products are mostly for domestic use. Farm animals are mainly cattle, pigs and poultry that are raised in Estonia. Moreover, Estonia is rich in some ecologically pure products such as wild barriers and mushrooms. The growth rate of agriculture productivity in Estonia is quite better than those of climate vise suitable countries, offsetting the effect of decrease arable land and climate effects with improved technology. Local produce contains less chemicals and organic farming is gaining momentum.

Estonia has 985,456 hectares of utilized agriculture land out of that 694,394 is arable. (Statistics Estonia, PM 0281). According to statistics Estonia, only agriculture output

accounts for 974,299.6 thousand EUR in 2020 (Statistics Estonia PM 54). Where the crops share represents half of the total that is 50.8%. Only cereal contribution to agriculture is 22.2%. whereas, in animal out put the one fourth of total comes from milk. (See table 2 in appendix).

Estonia is and has been the net exporter of milk. (Viira et al. 2009). The positive trend in productivity of dairy has been continue as reported by state agency statistics Estonia that milk sector shown a growth of 3 % in the year 2020.An indication of improved competitiveness of milk sector. The average milk yield per cow stood higher at 9,943 kg, a rise of 310 kg per year. The devoted land for farming has also increased from 3000 hectares to 983,000 hectares, validates this growth to remain continued (ERR News, January 2021).

On the other side field crops, especially cereals grew on 370,000 hectares of land which is 12 percent more compared to last year in 2019. The relative importance of crops has been changed in last decade, where the sown area of barley decreased compared to wheat. The increase productivity of cereal crops and oil seeds made Estonia an exporter of cereals yet, many fresh vegetables and fruits are being imported. (Viira et al.2009).

2.1.2 Food value chain (conceptual visualization of food production to consumption)

Pre dominantly, the entire life cycle of the food, from farm to fork, has gone through various stages, distinguished well enough, yet integrated and harmonious to make the end product valuable for the customers. According to the (FAO, 2014), the food supply chain combines all actors who contributes by value adding activities in each stage of food life and coordinates to deliver this value for the customers. (FAO, 2014). In most cases, these supply chains act dynamic and mostly are market driven.

In another words, the whole supply chain is a kind of “strategic partnership” among various growers, producers, market players and suppliers whose business remain inter-dependent. Main purpose has been to attain competitive advantage and creation of value for final customers. Hence, effective and efficient services that ensures a linkage among producers, retailors and final customers with focus market collaboration is fundamental and ultimate purpose of supply chain.

Certainly, global agriculture market is becoming complex in view of demand for food safety as well as quality. This led to wide opportunity for various players in whole supply chain to

initiate the new ways of valuation. Although, historically agribusiness sector remained commodity oriented with focus of product maximization and economies of scale. Yet, here too, the food and agriculture literature define the value adding in supply chain as the current state of product is being changed to most preferred state which is accepted at market place. (Cucagna and Goldsmith, 2018).

Vanyi, (2012) has defined the food value chain as functionally linked series of value adding processes, where several actors in supply chain (growers, transporters, storekeepers, processors, retailers and suppliers) create product that fulfill the needs of final customer. Therefore, the value chain analysis is crucial to understand the ongoing market dynamics, structure and partnership among various stakeholders that could potentially affect the growth of a sector and competitiveness of small farmers. (Wegari & Gelata, 2021).

A conceptual view of Estonian food system, categories the whole food supply chain into five distinct stages (figure:7). Since, it has been assumed that entire supply chain from food production to consumption has been followed by these stages. It is identified as (i) agriculture production that includes the farm level activities of harvesting and milking (ii) post-harvest stage includes handling of farm produce and storage of both grain and milk (iii) processing that involves in cleaning, value adding and packaging of the product (iv) distribution to both whole sellers and retailors and (v) consumer or household that uses the final product.(Bräutigam et al. 2014; Loke and Leung, 2015). Further, this supply chain may not follow the exact stages, distinguishing the type of food wherever is possible. Few steps overlap and occurs after every stage for instance, storage required after post-harvest and even before distribution, similar for transportation that is part and partial of every stage to be transformed to next. (Liu, 2014).

Figure 7 represent the conceptual view of Estonian food system that is true for all agricultural production in general and milk products, wheat, strawberry and potatoes in specific. Estonian Dairy consists of many producers and processors. Currently, the 40 milk processing companies are working in Estonia where 15 production units belongs to five owners. Generally, milk processing follows the stages of milking, chilling, transport to the purchaser, food processor or final consumer (Värnik et al. 2021). Various processed dairy products have been exported as the Estonia has more range of processed good compare to many Europe Union countries.

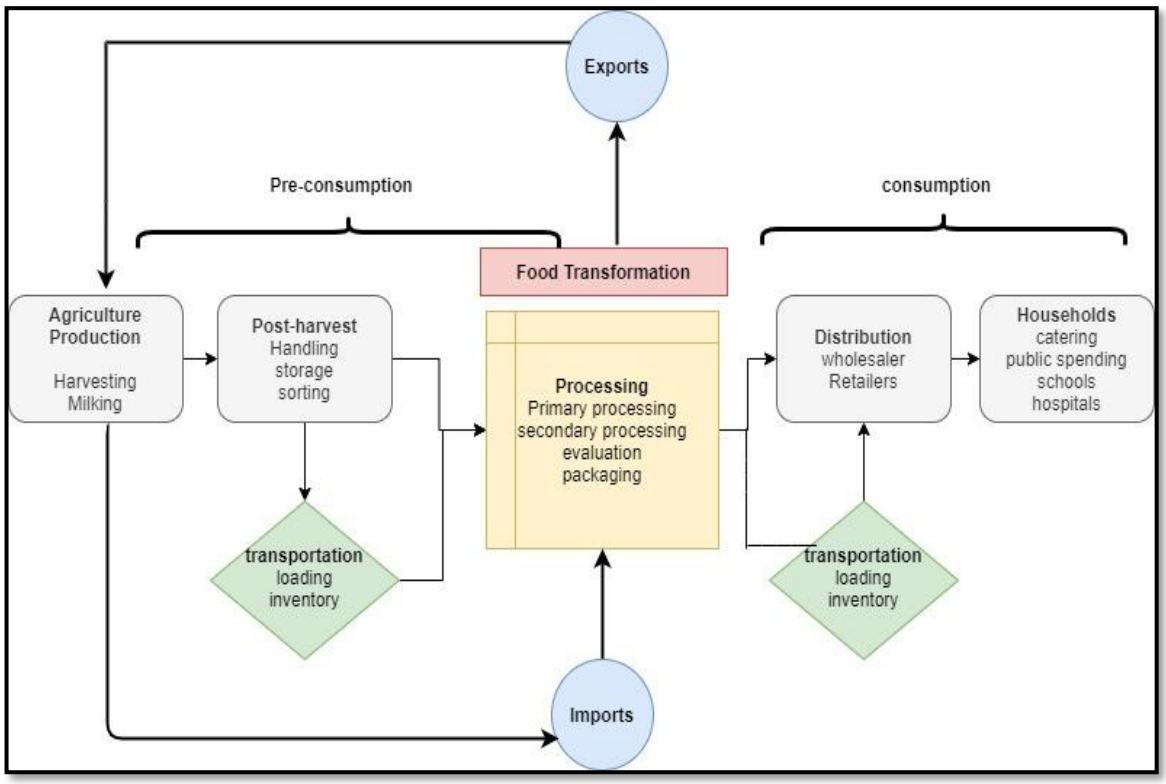

Figure 7. Food supply chain, a conceptual view (Source: Bräutigam et al. 2014; Loke and Leung, 2015)

Whereas, the wheat cultivation followed by the harvesting, pre-cleaning, drying, post-cleaning, storage, packaging and transportation to the purchaser or retailers. The dominant processing companies are AS Leibur, a bread manufacturing company and Estonian Malt OU that supplies the bread industry with thermally processed grains, seeds, bakery syrups and germinated grains. Similarly, strawberry and potatoes supply chain consist of harvesting, sorting, chilling, packaging transportation, food processing to final customers. Strawberry are being used as additive in milk processing whereas Balsnack is only potato chips manufacturing company in Estonia. Moreover D.T.L Consumer Product Estonia is wholesale and imported foodstuff provider to selected strong producers.

2.2 Losses in primary production and main causes with focus on Estonian primary production

As discussed in previous section, food losses and wastes occur in entire food supply chain. In this work only the primary production in Estonia has been focused for the analysis. Wide range of diverse elements cause losses in all links of supply chain, most of them are technical,

ecological, economical, behavioral as well as policy also influence these at large. (Role et al. 2012).

In general, the field crops are commonly affected and meant to losses because of inefficient technological ways adopted for planting, pests, insects, quality losses. Agricultural losses of livestock caused significantly by the death and sickness, and decreased milk production due to dairy cow sickness (mastitis) for milk. (Liu, 2014). Post-harvest losses include harvesting losses, when grain is threshed, winnowed or dried. Moreover, when animals are transported to the slaughterhouse, as well as losses along the chain during transportation, storage, and processing. (Bräutigam et al. 2014).

In order to determine, the causes of losses in primary production in Estonia, the main focus is on four products; wheat, potatoes, strawberries and milk. To be mentioned specifically, this analysis does not include animals rearing and non-physical (realized production is less than estimated) losses and wastes. Main focus is to establish the fundamental causes in losses of realized yield and uses. For instance, in the case of strawberries the local produce subject to losses mainly because it remains unsold, low selling price of imported strawberries led to intense competition in domestic market. Further, the labor shortage in harvesting period and perishable nature of strawberries cause degradation.

In wheat cultivation, the largest grain loss occurred during wheat harvesting (the average loss was 6.2%), as a result of which part of the harvest remained in the field. Also in 2018, the largest grain loss occurred during harvesting, because of tools involved in harvesting (tangential threshing device, rotary spreader, an axial drum). Another reason is unfavorable weather conditions during harvesting, the volatile climate at harvest has major impact on grains harvest. Technical faults in dryer functioning, during drying process cause the chemical changes in grain due to moisture. Further, in post- cleaning, low quality wheat sorted out, represents the quantity loss. At storage, losses are mainly generated when the storage place remain unprotected by birds and rodents. More or less similar reasons have been found in case of potatoes losses at farm level.

For milk, specifically, main causes of losses are associated with health of the herd, high somatic cell counts and use of antibiotics for treatment of sick animals. Thereby, unstable milk sent to sewers or used as animal feed. The losses occurred during cooling are mainly because of power losses.

Although, the fundamental reasons of losses depict the similar nature around the world. yet, some specific differences occur because of technological and climate conditions. Moreover, infrastructural changes also effect the nature and quantity of lost output.

2.3 Management of primary losses with focus on selected four commodities

Although, in case of Estonia, the fundamental causes of losses have been quite similar than those of expected to be at any level of primary production. Yet, there are some specific reasons to be considered before analyzing managerial solutions.

Strawberries being perishable product, highly depended on weather faces losses mainly on harvesting stage (30% in Estonia, table 3). The ratio of losses is higher for large producers compared to small farmers. The dominant reason could be the higher ratio of loss associated with machine picking compared to conventional harvesting. Moreover, June 2020, recorded 3 C higher temperate than average of the previous decade. This led to fast preparation of strawberries approximately two weeks earlier. The unpredicted situation and non-availability of pickers, led produce being damaged, began to ferment and spoiled.

Table 1 Food Losses in Strawberries growing (Source: Varnik et al. 2021)

		Harvesting	Sorting	Cooling	Packaging	Transport to the purchaser, food processor or to the final consumer	Total 2018 study *		Northern countries study (2016) **
Size group	Large producer, middle	47.5%	4.8%	0.4%	0.3%	0.2%	53.2%		
	Small producer, middle	33.2%	8.9%	0.8%	0.5%	0.3%	43.7%		
Regular Producer, average		35.9%	7.6%	0.9%	0.5%	0.4%	45.3%		
Organic Producer, medium		39.1%	8.9%	0.2%	0.4%	0.1%	48.4%		
Middle		36.8%	7.9%	0.7%	0.4%	0.3%	46.1%	27.8%	28.0%
Median		30.0%	3.0%	0.0%	0.0%	0.0%	33.0%	22.5%	

Considering the risk posed by the weather, advance information system could potentially keep farmers aware of threats, making them prepare to reduce the extent of risk of damages.

Therefore, a reduced strawberries loss in event of likelihood of weather deterioration could be expected. Though, the management of labor force in season proved to be a challenge for growers. But the changed situation and ease of covid restriction, somehow, assures that situation will get better. For farmers, more vigilant advertising campaign could be a source of getting required numbers of labor on time.

It is evident, that strawberries sorting caused 7.9% of losses (table 1), when product is rejected due to cosmetic (color, shape, size). Customers' training and awareness would make these lost produce to gain acceptance since these strawberries could be used by the milk processors as additive that does not requires the product shape in specific.

Milk: Losses in milk production is comparatively lower in group of four commodities. Yet, the milking and cooling itself accounts for 3.3% and 0.2% of overall loss generation (table 2). Unlike strawberries, here the small farmers are the most effected group.

Table 2 Food losses in milk production (Source: Varnik et al. 2021)

		Production chain			**Total**			
		Milking	**cooling**	**Transport to the purchaser, food processor or to the final consumer**	**2018 study ***	**2017 study ****		**Northern countries study (2016) ****
Size - group	**Large manufacturer, middle**	2.6%	0.2%	0.0%	2.8%	2.6%		
	Small Producer, middle	3.7%	0.2%	0.0%	3.9%	3.1%		
Middle		3.3%	0.2%	0.0%	3.5%	3.1%	4.25%	0.6%
Median		2.0%	0.0%	0.0%	2.0%	1.0%		

Food losses report (Varnik et al. 2021) suggest that the higher losses are being associated with automatic milking carousel and tube miking compared to the use of milk robots. The lack of access of small farmers to advance technology due to financial constraints is perhaps the reasons. Staff skill and periodic training sessions for use of technology is crucial. Moreover, better animal health care, herd renewal and maintenance of equipment's' are also essential.

Wheat: Estonia has been characterized by the intense cold weather. That is by and large proved to be a challenge for field crops. The higher rate of losses is at harvest stage. Compared to overall losses 9.7% in wheat, 6.2% are at harvesting stage (table 3).

Table 3 Food losses in wheat growing (Source: Varnik et al. 2021)

		Production chain							Total			
		Harvesting	**Pre-cleaning**	**Drying**	**Post-cleaning**	**Storage**	**Wheat packaging**	**Transport to the purchaser, food processor or to the final consumer**	**2018 study ***	**2017 study ****		**Northern countries study (2016) ****
Size - group	**Large manufacturer, middle**	4.30%	1.20%	0.80%	0.60%	0.40%	0 %	0.10%	7.40 %	10.10%		
	Small Producer, middle	8.20%	1.70%	1%	0.70%	0.20%	-	0.10%	11.90 %	11.40%		
Middle		6.20%	1.50%	0.90%	0.70%	0.30%	0 %	0.10%	9.70 %	11%	42.70%	15%
Median		2%	0.50%	0%	0.60%	0%	0 %	0%	3.10 %	3.70 %	39.70%	

In some cases, growers immediately resell crop to whole sellers. Yet, the pre-cleaning and post-cleaning stages reflects minimal losses that are partly because of low quality of grain. A careful management, thereby, requires timely harvesting, use of plant protection technologies, maintenance and timely checks of dryers. Nevertheless, the role of wheat cooperatives in providing technical assistance and supports to farmers cannot be denied.

Potatoes: Contrasting to other agriculture productions. Considerable amount of potatoes loss (33.7%) is significantly due to prolong production cycle that usually last up to ten months. Hence, each stage requires separate and keen management. for instance, on harvesting 8.3% (table 4).

Table 4 Food losses in potatoes growing (Source: Varnik et al. 2021)

	Production chain					Total	
	Harvesting	**Sorting**	**Preservation**	**Packaging**	**Transport to the purchaser, food processor or to the final consumer**		**Northern countries study (2016) ****
Middle	8.30%	13.90%	6.40%	4.90%	0.20%	33.70%	12.5%
Median	5%	10.00%	5%	1.50%	0%	21.50%	

Potatoes remain in field mainly due to manual pickers of tubers. Where, the size of tube led most potatoes in filed. The required technical changes, application of agro- technical techniques (crop rotation, balanced fertilizers), the use of machinery and equipment correctly and renewal of machinery is significant. Effective implementation of rodent control to avoid fragmentation and integrated pest management techniques along with certified seed use is possible solution.

2.4 General characteristics of foreign trade and main trading partners of Estonia

Estonia, being a small country must have to take active part in foreign trade, not only to fulfill the demand requirements, yet, to ensure the existence in trading world. Local producers can potentially respond to fraction of both consumers and producers demands. (Reiljan et al.. 2000).

Although, the role of foreign trade seems to create a balancing effect in Estonian economic situation, for instance, the producers with surplus production due to economies of scale or general trend of product specialization, will be restricted by limited and low local demand. Therefore, essentially, they have to flow this surplus to foreign market. First, for making the produce being sold on competitive prices. Second, to avoid produce to be lost and spoiled and most importantly for trade gains, being the part of transition from inter-industry to intra industry.

A strong economic situation required the trade effect to remain balance. Estonia has always emphasized on development of foreign trade. Specifically, Estonian food market has

potential demand for variety of high value-added products' import (ITA, 2020). Demographically middle, high income and growing expatriate community is perhaps the main demand creators. Further, the part of food demand is being generated by large Scandinavian and Baltic Grocery Chains. Their development and appreciation among local community generates wide opportunity for exporters. Although, fresh domestic products of food items without additives have increasing demand. Yet, Estonian consumers remain price sensitive. Rising trend in organic food is one side of the picture while young segment of consumers has new product demands that is an encouragement for imports.

Currently, the import volume of food stuff surpasses than exports. In Estonia, the imported food stuff origin to EU member states. (Statistics Estonia, 2020). Hereby, it is important to mention that agriculture production in EU members states is mostly subsidized to make their prices either stable or cheaper even. Hence, the EU domestic market is protected by import restrictions to producers outside EU. This is perhaps the one reason that Estonian agriculture and food stuff mainly origin to EU states. Whereas, the local diets and preferences could be the other main reason.

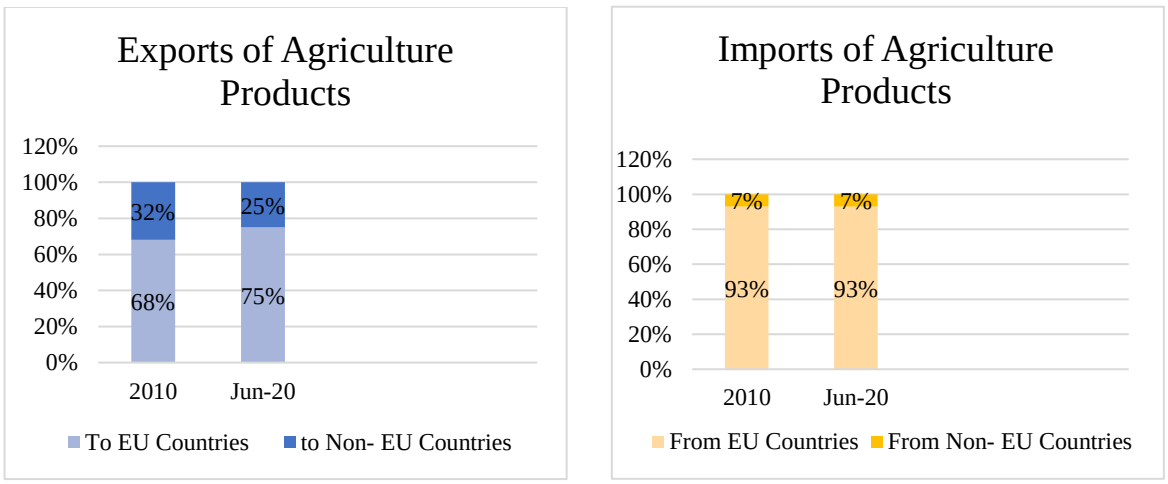

Figure 8. Import/ exports of agriculture products to EU and non- EU countries (Source: Directorate General for Agriculture and Rural Development, based on COM EXT data)

The exports of agriculture products to EU countries have been rising from 68% in 2010 to 75% in mid of 2020, compare to non- EU states where this ratio is decreasing from 32% in 2010 to 25% in 2020. Whereas, the imports from EU and non-EU countries remain stable to 93% and 7% respectively through the period from 2010 till 2020 (European Commission, 2021).

2.5 Key trading partners and their significance in Estonian trade

As the foreign trade is part and partial of Estonian economy, so is the structure of trading partners in the region and around the world. There is no denying the fact, that both from economic and political point of view, there have been consistent emphasize on trade relationships with strategic and regional partners. (Reiljan et al. 2000).

The fundamental principles of Estonian economic policy are based on flexibility, openness, liberal trade and investment laws. The Wall Street journal and Heritage Foundation's index of economic freedom 2017, ranks Estonia 6th out of 180 freest economies in the world (ITA, 2020). Estonian's main trading partners are Lithuania, Latvia, Finland, Germany and Sweden. Yet, most important countries of exports are Finland, Sweden, Latvia, Russia, Lithuania, Germany, Norway, Netherlands, Denmark and United Kingdom. Whereas, the major share of imports is from Finland, Germany, Lithuania, Sweden, Latvia, Poland, Russia, Netherlands, China and United Kingdom. Further Estonia has agriculture food surplus trade with United States, it is the net food Exporter. (Purju, 2019).

Here, it would be relevant to mention that being an emerging trading country Estonian export structure is quite logical, where main exports partners are neighboring countries. Five biggest export partners exhibit the great geographical concentration. Although, it is hard to predict the future trend and diversification of this regional trade. Since, short term symbolizes the existing pattern to remain same.

Significance of Finland, being a trading partner cannot be denied. factual context regarding imports of Estonia shows the lack of knowledge among Estonian importers about actual sources of demanded goods in world market, made Finland to act as country of transit, thereby, western products unrouted to Estonia through Finland. Being largest trade partner Estonian exports to Finland account for 14.4 billion EUR that is 15.9% of Estonian exports in year 2018.Whereas, the imports are 2.1 billion EUR in same year (Purju, 2019).

Apparently, balance trade policy, economic and political stability, EU common market, equilibrium in foreign trade, equal opportunity for domestic and foreign producers in local market, and absence of trade restrictions, make Estonia a favorable place for traders.

2.6 Current situation of primary agriculture output, domestic consumption and agri-food trade of Estonia with focus on (four selected commodities)

Currently, the Agri- food trade balance in Estonia is negative. Outside EU this trade balance is positive, yet, fluctuating. The dominant reason for this positive trade balance seems to be trade surplus of Estonia with United States. However, the intra-EU situation is quite different. Main exports consist of cereals and milk while potatoes and strawberries are being imported (European Commission, 2019).

The recent data of agriculture represent that overall agriculture output in 2020 accounts for 975 million EUR, out of this only crop output is 48.30 % that is 471,3 million EUR. Wheat output is 123,329.7 EUR represents 26.1% of total crops production (PM55, Statistics Estonia). In 2019, the animal production was 46.1% of total agri-food sector, where milk being dominant commodity accounted for 26% (European Commission, 2021).

The overall, agriculture production in Estonia has been increased compare to previous years. Both for milk and wheat, realized production was 3% and 5% more respectively, than a year before. Although, the utilized agriculture area was 3000 hectares more as Estonian farmers cultivated cereals on 370,000 hectares of land, that was approximately 2% larger area than 2019. Similar trends have been observed in productivity of milk. The reported average milk productivity per cow grew to 9,943 kg that is 310 kg more than previous estimates (Statistics Estonia, 2021).

Predominantly, the large enterprises accounts for growing share in agriculture production. According to survey conducted by Statistics Estonia current agriculture holdings are 11400, 84% of these holdings are used by 1300 largest producers. About 65% of the utilized agricultural land is rented from other landowners. They cultivate more than two third of agriculture land in Estonia (Statistics Estonia, 2021).

Table 7 shows the production, domestic demand, import and export figures for last three consecutive years (2018-2020). Harvested wheat significantly growing throughout the period. From 2018 to 2019, the production of wheat has almost doubled. Though, the bumper crop of wheat has been sufficient enough to meet the local demand. Yet, the higher yield has affected to lower the imports in subsequent years.

Table 5 Agri-Food production, consumption imports and exports (2018-2020) (Sources: Statistics Estonia, PM20; PM31; PM0281; PM54, PM178 Eurostat: APRO_MK_POBTA, Lennart Käämer, 2019. Worldbank 2018-2020, HS 081010)

		2018	2019	2020
Cultivated Area (hec)	Wheat	154,579	166,984	168,038
	Potatoes	5,205	5,336	3,639
	Strawberries	740	748	685
Production (tons)				
	Wheat	450,265	846,579	840,519
	Potatoes	88,434	120,502	94,414
	Strawberries	1,951	1,862	1,685
	Milk	779,960	777,760	840,519
Consumption (tons)				
	Wheat	213,694	216,917	218,020
	Potatoes	129,348	145,317	136,332
	Strawberries	-	-	5000/6000
	Milk	748,100	763,100	787,600
Imports (tons)				
	Wheat	32,171	25,151	23,873
	Potatoes	49,648	51,372	45,132
	Strawberries	3584.03	-	3002.99
	Milk	31000	13,900	13,200
Exports (tons)				
	Wheat	226,703	608,304	736,605
	Potatoes	9,723	15,018	12,601
	Strawberries	34.51	-	1228.66
	Milk	199,900	197,700	206,100

Compared to 2018, this ratio has fallen to 21.8% in 2019 and 25.7% in 2020. On the other side, exports of wheat are surging three times in between 2018 to 2020. The trends have been shown in figure 9.

The aggregate worth from exports of wheat from Estonia is $155 million in 2020. Whereas, it was $105 in 2019. The sales increase estimated to be 47% for one year. Yet, the export of wheat is 0.915% of total exports of Estonia that is again slightly more than previous year

when it was 0.7%. 29% of total wheat exports earnings are from Morocco, followed by Netherlands with 11.2%. The value of imports, on the other hand decreasing, that estimated to be 22% less in 2020 compared to last year. (See table 8). Latvia has the largest share in Estonian wheat imports with 84% share ($1.95 million) (Trend Economy 2020, HS02, 1001).

Table 6 Import and exports earnings (2019-2020) Source: Annual International Trade Statistics by Country (HS02), https://trendeconomy.com/data/h2/Estonia

Wheat (1001)	**2019**	**2020**	**Percentage change**
Exports	$105 M	$155M	47 % increased
Imports	$ 3 M	$2.32 M	22 % decreased
Potatoes (0701)			
Exports	$ 2.03 M	$986 Thousands	51% Decreased
Imports	$3.58 M	$1.66 M	53% decreased
Strawberries (081010)			
Exports	$1.22 M	$1.45 M	18.6% Increased
Imports	$3.62 M	$3.59 M	0.64% decreased
Milk (0401)			
Exports	$83 M	$86 M	3.02% increased
Imports	$8.17 M	$8.1 M	0.832 % decreased

Similarly, in case of potatoes, though showing fluctuating trends in production in the last years, yet, aggregate production has been rising. While domestic demand has slightly decreased in 2020 compare to 2019. The ultimate impacts are seen on imports. Domestic production could only fulfill fraction of domestic demand, for instance, in year 2020 domestic production accounted 69.2% of total local demand for potatoes. Giving a rational for imports, that was 45,132 tons (PM31, Statistics Estonia). But this volume was 12% lower than imports of potatoes in 2019. Figure 9 is a visual representation of trends in production, consumption, import and exports figures of potatoes in last three years.

Reference to table 6, the total exports of potatoes decline by 51% in 2020 compare to 2019, by only adding $986 thousand value to total exports. The net exports of potatoes counted to be 0.005% of total Estonian exports. The fresh and chilled potatoes are mainly exported to Poland and Finland. On the other hand, Potatoes being imported commodity shares $1.66 million in 2020, 53% less than a year ago. This is probably the decline in domestic demand

in between this period. Estonia imports 21% of potatoes from Lithuania (Trend Economy 2020, HS02, 0701).

The production of strawberries has declined throughout the period (see table 5). the shortage of labor during harvesting season resulted in spoilage of yield. The covid 19 and restriction on cross border labor mobility has left the farmers with no choice but to leave a part of the crop unharvested in field. Or delayed harvesting (BNS, ERR News, 25 May 2020). Contrarily, to production volume, the exports are 18.6% more in 2020 than 2019. (See table 5). While there is slight decline in imports as well. Latavia is the main importer of Estonian strawberries followed by Poland. Yet, Estonia imports strawberries from Greece and Spain.

Figure 9. Production, consumption and trade of four commodities

As discussed earlier, Estonia as net exporter of milk, still showing remarkable growth in dairy sector. An average milk yield per cow has grown. Hence, trade statistics shows that exports have been increased to 3.02%. while the share of milk is 0.509% of total Estonian exports. Lithuania has greater demand for milk produced in Estonia. Lithuania has 53% share in Estonian milk exports (Trend Economy 2020, HS02, 0401).

3. MANAGEMENT OF LOSSES, POSSIBLE APPROACHES AND LIMITATIONS

3.1 Structural assessment of approaches for improved target management of losses

The unsustainable level of food losses, necessities understanding the scope of problem along with the guided actions to eliminate and reduce the losses of valuable resources. Certainly, all the food produced in orchards, farms, pastures, green houses or feedlots are intended for human consumption. Each grain, fruit and dairy product make their way successfully through following various steps in food supply chain. Where the losses are generated in each stage. The effective management approaches adopted to exclude these losses would considerably reduce those effects on ultimate production. A focused approach to minimization of food losses requires clear action plans that targets the main issues. (FAO, 2015).

In general, food supply chain accounts for upstream (primary production, post-harvest) and downstream (processing, distribution and consumption) losses. As the matter of fact, with focus on upstream losses, there have been several drivers and pressures that generate the losses during processes. Some of them could be controlled and other are stagnant as out of human capacities. So, management approaches vary according to their nature of occurrence, drivers and system pressures. (Spang et al. 2019).

Figure 10, shows the upstream losses, their possible divers, included system pressures and their management approaches. Pre-dominantly, primary production largely effected by partially controllable phenomena of climate effects that end up with limited solutions, including the cultivation of suitable crop according to season. (Bradford et al. 2019). Further, market acceptance criteria based on product specification proved to be a driving force for such losses at primary stages, where initial sorting of various substandard produce according to cosmetics (size, shape, colure) is made. Thereby, taking the market participants into picture, especially, food processing companies help rising awareness for such produce to be given acceptance. Certainly, marketing solution for such substandard produce is to be sold out in lower prices to retailers or processing companies. (Johnson et al. 2018).

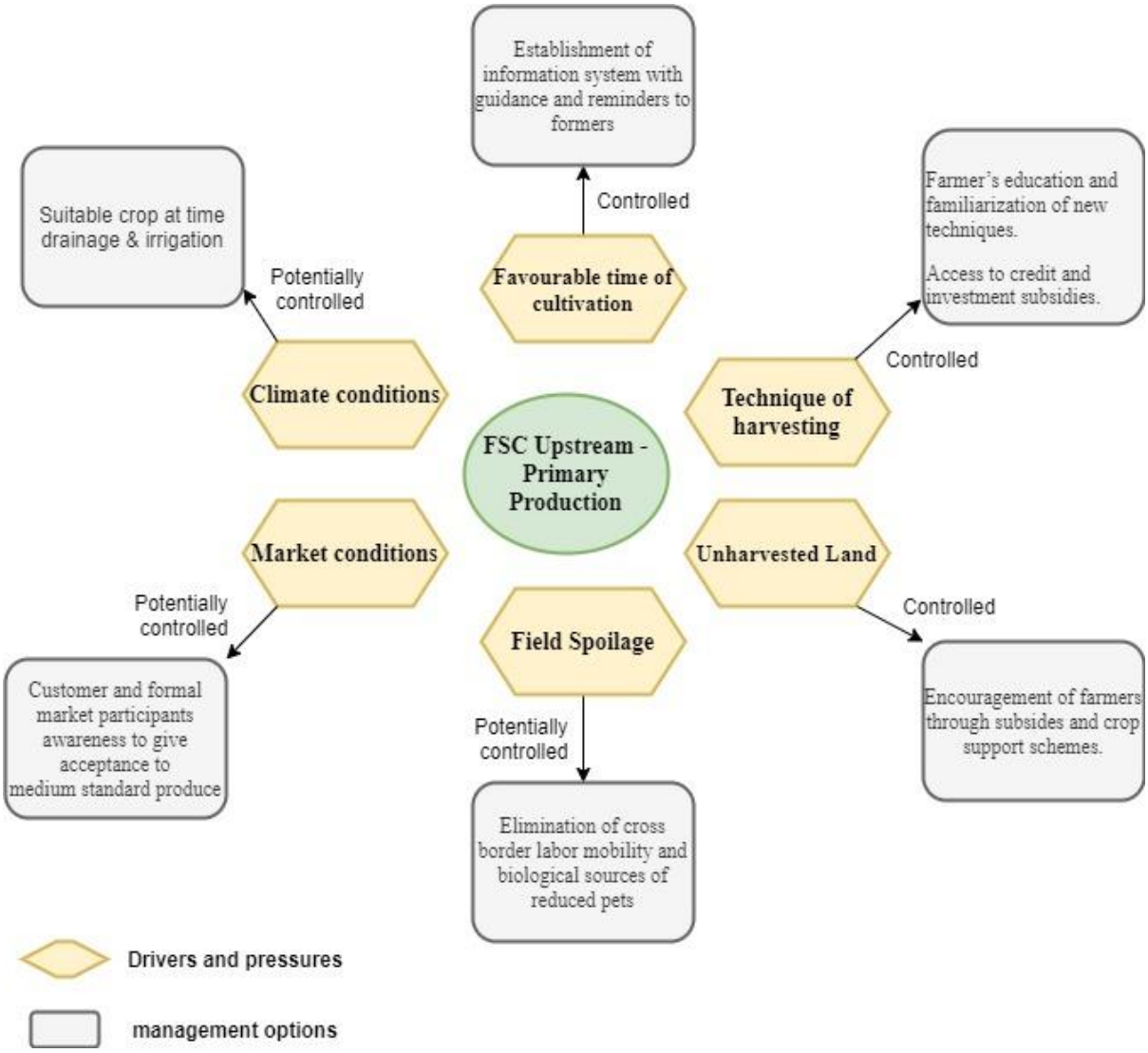

Figure 10. Structural assessment of losses, their drivers and pressures, nature of state and management options at primary production level (Source: Bradford et al. 2019; Johsnson et al. 2018; Spang et al. 2019)

On the other side, after harvesting the fresh produce requires a careful handling to avoid losses at this stage. (see figure 11) Most of these losses are in human capacity and could be controlled. For instance, lack of financial means for upgradation and maintenance of infrastructure has been a prominent driver of loss generation. A small farmer has been rather incapable of having access to such technical facilitation including storage standard and transportation required to maintain the produce fresh. Therefore, farmers' cooperatives serve such purposes to provide the farmers with technical assistance. Although, the upstream supply chain is less likely to have processing and packaging losses. Yet, their existence and contribution in lost food quantity cannot be neglected. Hence, a precise approach by keeping records of produce during processing (drying, sorting, packaging etc.) would enhance product availability. (Bradford et al. 2018; Alavi, 2011).

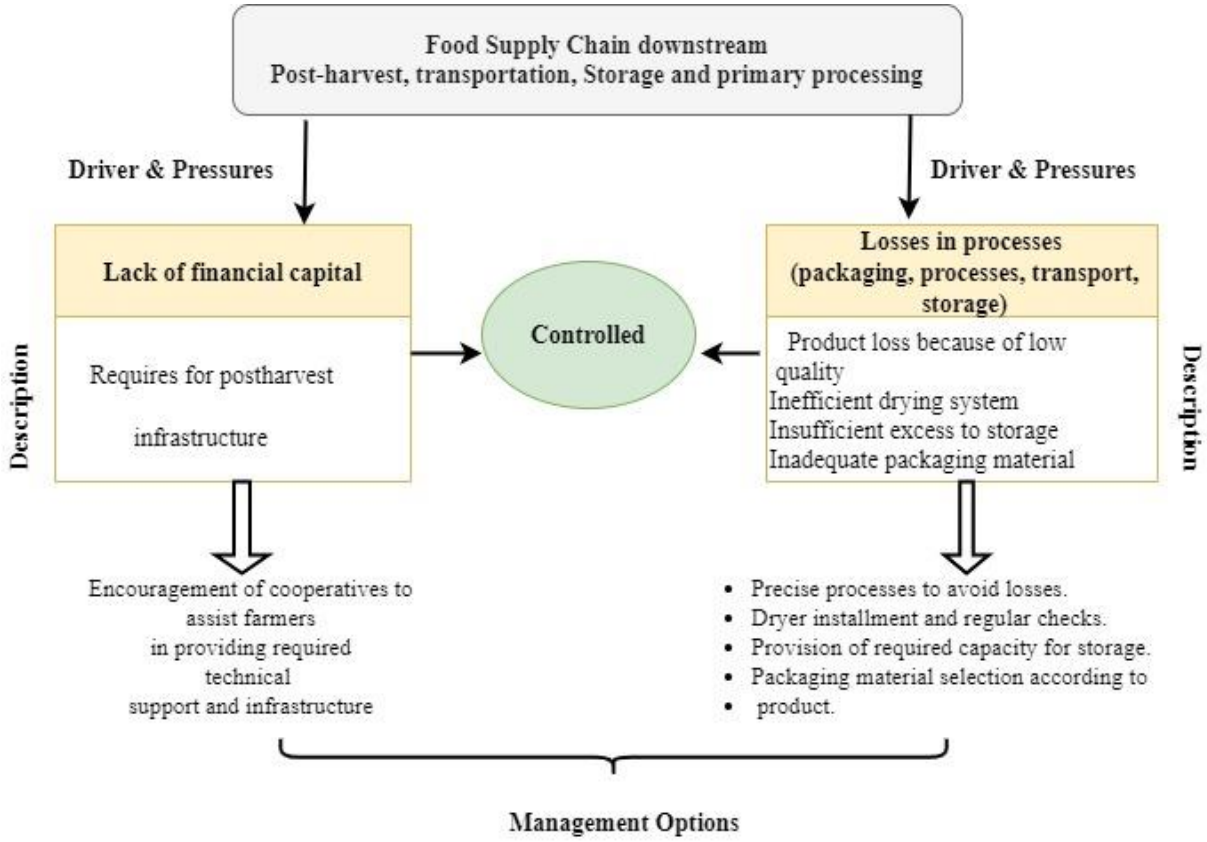

Figure 11. Structural assessment of losses, their drivers and pressures, nature of state and management options at post-harvest level (Source: Bradford et al., 2019; Johsnson et al. 2018; Spang et al. 2019)

3.2 Limitation in practice and hurdles in effective implementation

In general, the effective management of losses lacks the recognition of concept among common masses. The problem is further compounded in absence of policies, legislations, that sets a clear managerial framework for reduction of losses by both public and private stakeholders. As the matter of fact, the EU food industry is highly regulated, that results useable produce being condemned. (Saltmarsh, 2020). Required certification and licensing associated with produce quality reflects higher standards, leading some moderate quality to be left for fermentation and spoilage. Thereby, it is safe to conclude that regulatory barriers, license policies and permits somehow, causses these losses.

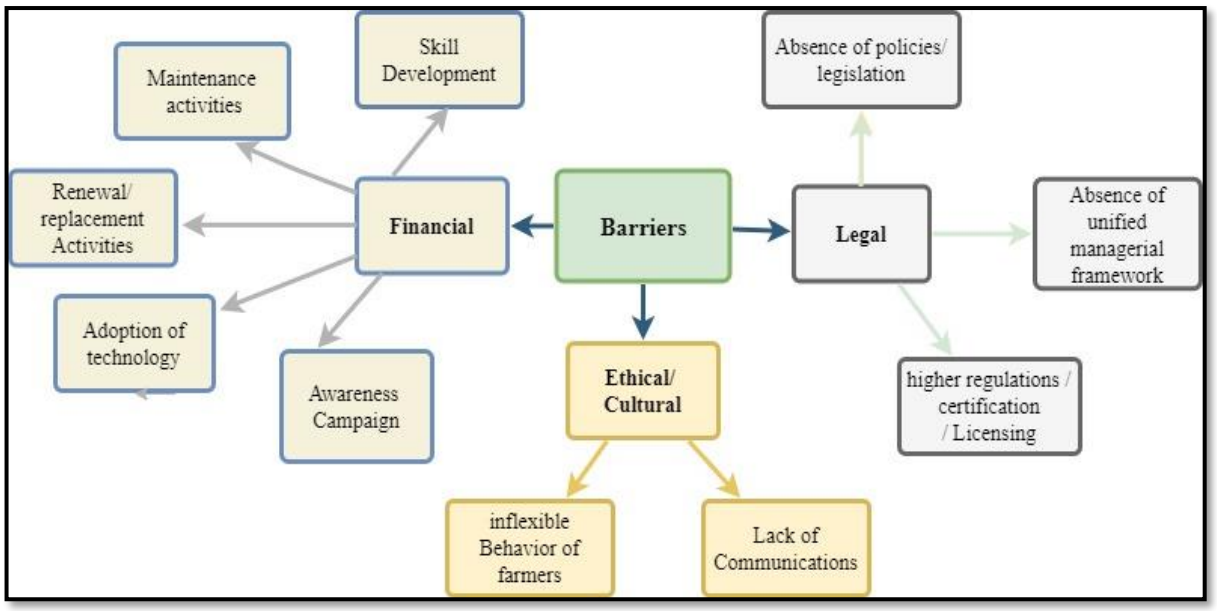

Figure 12. Legal, financial and ethical/ cultural barriers in practice (Source: Saltmarsh, 2020; Jenkin et al. 2017 and Spang et al. 2019)

Given the ethical, social environmental and economic costs of food disposal, the legal boundaries are prerequisite to control these losses. Further, at policy level, the broader framework for unified action could be fruitful in directing, coordination, implementing and incentivizing the efforts being made by different actors. The absence of such policy at public level lacks the coordinated efforts at large. (Jenkin et al. 2017).

One of the major hindrances in effective implementation of the target action is financial limitations, for instance, most of the maintenance activities, adoption of new technology, robots used for milking, dryers checks and replacements, new and extended storage facilities, packaging materials and their standards, largely dependent on financial capital flows. (Spang et al. 2019). There has been a cost associated with each action set for minimization of losses. Despite, the long-term effectiveness of these managerial actions, there short-term implication attached with greater costs e.g., primary packaging technology and selection. Further, the customers awareness to give acceptance to moderate quality products required extensive and persistent awareness campaigns, comes up with costs.

Another point worth mentioning, is lack of ability and inflexibility of farmers to adopt the required new approaches that would reduce losses, most of them are associated with farming methods. The insufficient skills and capacity to identify the reasons of losses, itself is alarming situation. Moreover, a strong commitment and communication among growers and processors is required, the absence of this, in general restricts the absorption of large quantity

of food as being not accepted within the formal sector e.g., a part of locally grown strawberries are spoiled in Estonia particularly because they remained unsold. On the other side producers of processing companies are importing strawberries because they are cost effective. In presence of communication between both growers and processor, agreement could be made on acceptable prices for both the parties, that would result in reduction of losses in one hand and decrease in imports volume in other side.

3.3 Informed selection of management methodologies and their benefits

There is no denying the fact, that greater inefficiencies imply greater opportunities for saving resources too. keeping in view the set target of 50% reduction in food losses by European Commission by 2020, suggests this as leading strategy for attaining sustainable food for future.

In general, the redistribution of food is suggested to avoid losses. The applicability of some kind of avoidable, unavoidable and potentially avoidable losses reduction are possible while using food waste as animal feed. Another best option could be extraction of some compounds of interest from lost food e.g. fats by trimmings via rendering plants can be used as animal feed. Though, several aromas, coloring including essential oils could be extracted from spoiled fruits and vegetables. Yet, the most favorable is organic waste that decompose and in absence of oxygen convert in biogas. (Rollett et al. 2015).

In view of implication, there have been numerous social, ecological and economic benefits of reducing losses. Since, the rural development and poverty reduction is attributed with farmers' well-being. In specific, lowering post- harvest losses can improve quantity of food available to farmers for their own consumption as well as for sale. Therefore, the reduction in losses could turn small-holders from food buyers to net food sellers in the market. A greater benefit, is thereby, recognized as lower per unit cost associated with input required for cultivation and harvesting. Moreover, the land use for certain quantity of produce will reduce, making farmers better off by giving them more choices. Either to extend the production of same crop or to engage in other activity for efficient use of land.

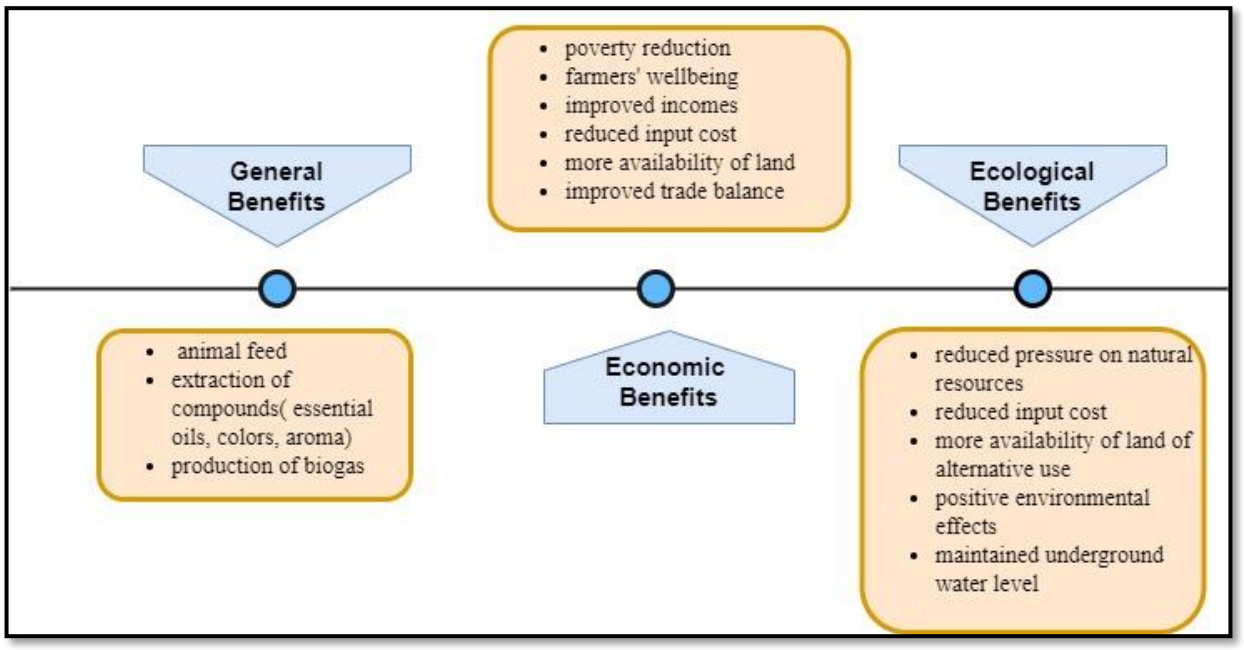

Figure 13. General, economic and ecological benefits of controlling losses Source: Rollett et al. 2015; Lipinski, 2013; Lipinski, 2013 and Liu et al. 2013)

From economic point of view, reducing losses increase the return in investment made by farmers. More convincingly, a huge quantity would be made available to sell in the market. This would cause the farmers to earn financial gains. (Lipinski, 2013). At national level, the quantity flow of produce will lead to excess supply to meet the demand at domestic level. Infect, in such case the excess produce replaces the imports to improve the trade balance.

The Environmental and ecological benefits are several and widely discussed in literature. Logical reasoning suggests, that the rational use of available food, reduce the need to convert more ecosystem into food production. Thereby, it helps conservation of ecosystem. Avoiding agriculture expansion by replacing it from forests land. Further, it gives more opportunity raise more livestock. The climate stabilizing effect of reduction in losses are quite prominent. It helps reduce the greenhouse gas emission from agriculture by acting as stabilizer. (Lipinski, 2013).

Generally, better management of losses eliminates the pressure on natural resources. For example, it preserves the underground water used for irrigation. Hence, left with little or no chance of contamination of water by agriculture chemicals. In other words, it stops depletion and contamination of water resources at the same time. (Liu et al. 2013).

4 MATERIALS AND METHODOLOGY

4.1 System boundary and scope of the study

This study is accounted for the food losses and wastes generated in the primary production stages in Estonia in 2020. Figure 14, represents the scope of this work. Since, the quantification of data is ongoing and in Estonia only the data related to primary production (pre-harvest and post- harvest) is quantified. So, the losses generated in the rest of the staged of food life cycle (processing, distribution and consumption) has been considered as out of scope of this analysis. Further, four commodities; (wheat, potatoes, strawberries and milk) has been picked from the entire Estonian food basket. The milk and wheat are exported commodities while strawberries and potatoes are being imported by Estonia. This will probably make the analysis clearer to understand the effects on imported and exported commodities. Further, the losses data related to these commodities have been published, establishing a reason to analyze the relative effects on trade of these commodities.

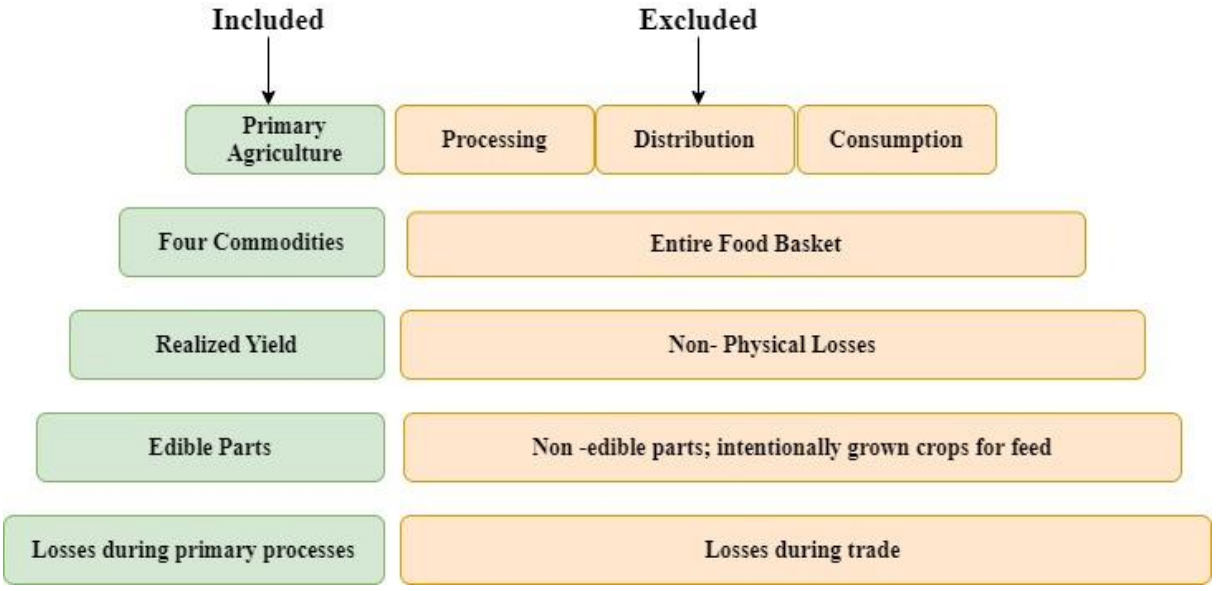

Figure 14. System boundary and scope of analysis (Author)

Another point worth mentioning is that the losses in realized yield or production and their edible parts has been estimated for this work. Whereas, the non-physical losses (realized yield is less than estimated) have excluded. For instance, there is possibility that the actual production of some crop remains less than estimation. In that case, it would have been a loss. Yet, it never represents in physical existence. Hence, all non-physical losses in primary production stage have not been considered.

Moreover, some crops which are intentionally cultivated for animal feed and non-edible parts of commodities are also excluded. Another fact is this, that in most of the cases the cultivation is meant for human consumption. There is logical link among the quantity demanded and losses of edible parts. Food losses in primary production defines all sort of damages, degradation in quantity produced during crop planting, animal production, thrashing, sorting, primary storage, primary processing, and transportation. Any losses occurred during trade of these commodities will not represented by the lost amount.

4.2 Conceptual approach

In an open economy, income and price of commodities determine level of imports and exports. Further, the trade is balanced with tariff and subsidies depending on intensity of demand for certain commodity in local market. (Khan et al. 2010). No doubt, there would have been the other factors that contribute to attain or improve such a balance. For instance, a part of demanded imports could be reduced with the rational use of available produce. Moreover, improvement in production procedures by achieving economies of scale and production specialization will in turn have impact of imports and exports quantities.

In context with agri-food products, with perishable nature of commodities, makes them sensitive to be traded to far-off regions. A higher degree of risk for spoilage of such commodities is being associated with trades. Yet, their trade is essential in absence of local produce probably because of unfavorable climate conditions, low quality of yield or related wastages in supply chain. (Sarkar et al. 2007)

With regard to the topic under consideration, the reduction in losses generated in each stage of supply chain could also help to improve the balance of trade. In general, avoiding losses in supply chain activities would ensure the improved quantity supply, available for consumption. Assuming that in presence of lower local demand that is fixed, at least, in the given period, the surplus production would either reduced the imports or in turn would create value through exports gains.

The literature sections provide enough understanding for the food losses and trade facts of the selected four-commodities. So here, Figure 15, establish a relationship between reduction in losses and trade effects. The plant-based commodities (wheat, potatoes and strawberries) are separated from milk according to the nature of their supply chain. The producers ‘production supply chain for commodities are given below;

- Wheat: cultivation, harvesting-cleaning, drying, post cleaning, storage, packaging of wheat, transportation to processors.
- Potatoes and strawberries: growing, harvesting, sorting, preserving, packaging, transportation to purchasers.
- Milk: milking, chilling, transport to food processors. (Varnik et al. 2021)

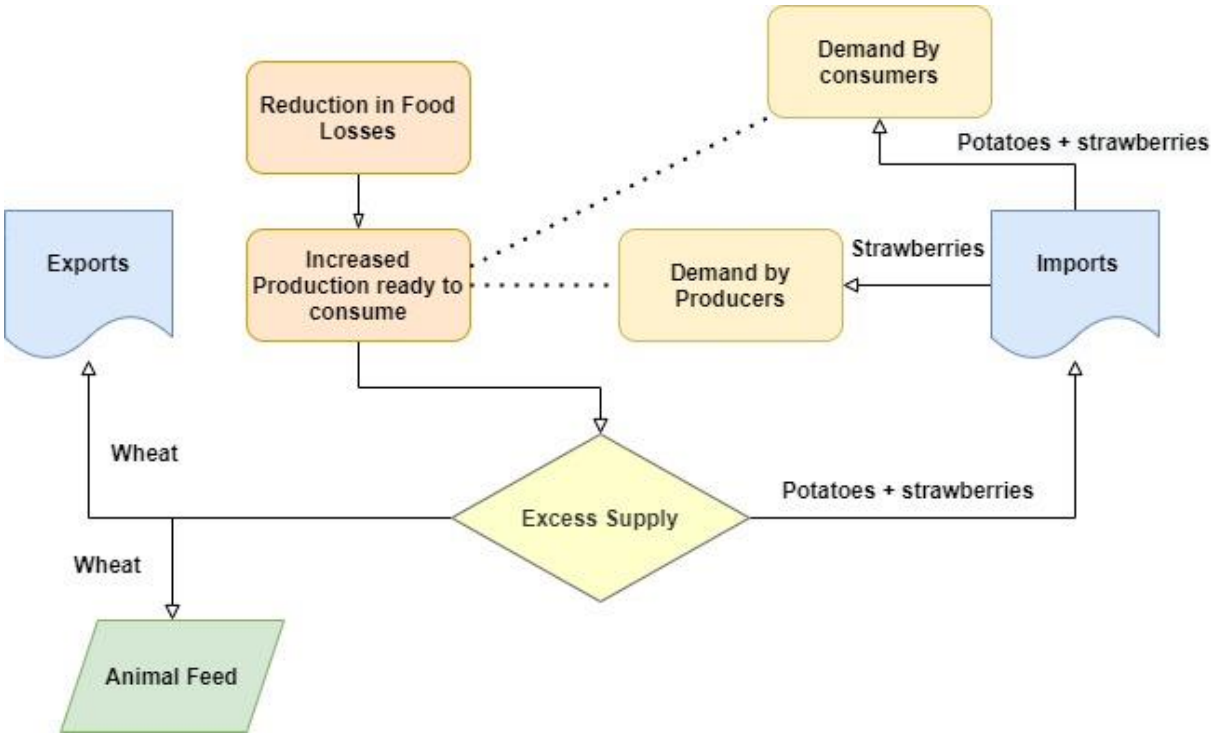

Figure 15. Relationship of reduction in plant-based food losses and trade balance (Author)

Therefore, in producers' production chain any reduction in losses because of managerial or technical efficiencies and improvement in production processes at farm level, will sufficiently increase the realized production, ready to enter in next stage of supply chain. In case of wheat, in Estonia more than 70% of total production goes for animal feed. In wheat, reduced losses, will increased the quantity supply of produce for consumption. In presence of given domestic demand in short run of that specific period. The quality of grain determines its flow as exports or animal feed for local consumption.

In Estonia, strawberries' domestic market is in competition because of cheap imported strawberries. Producers involved in processing are perhaps the main demand creators for strawberries imports. Thereby, the reduction in losses of strawberry would lead this excess production to fulfill the import demand. Since local market is price sensitive both by consumers and producers but the additional supply would in turn effect the domestic prices

too. On the other hand, reduction in losses will potentially reduce the imports for potatoes and fulfill a fraction of local demand.

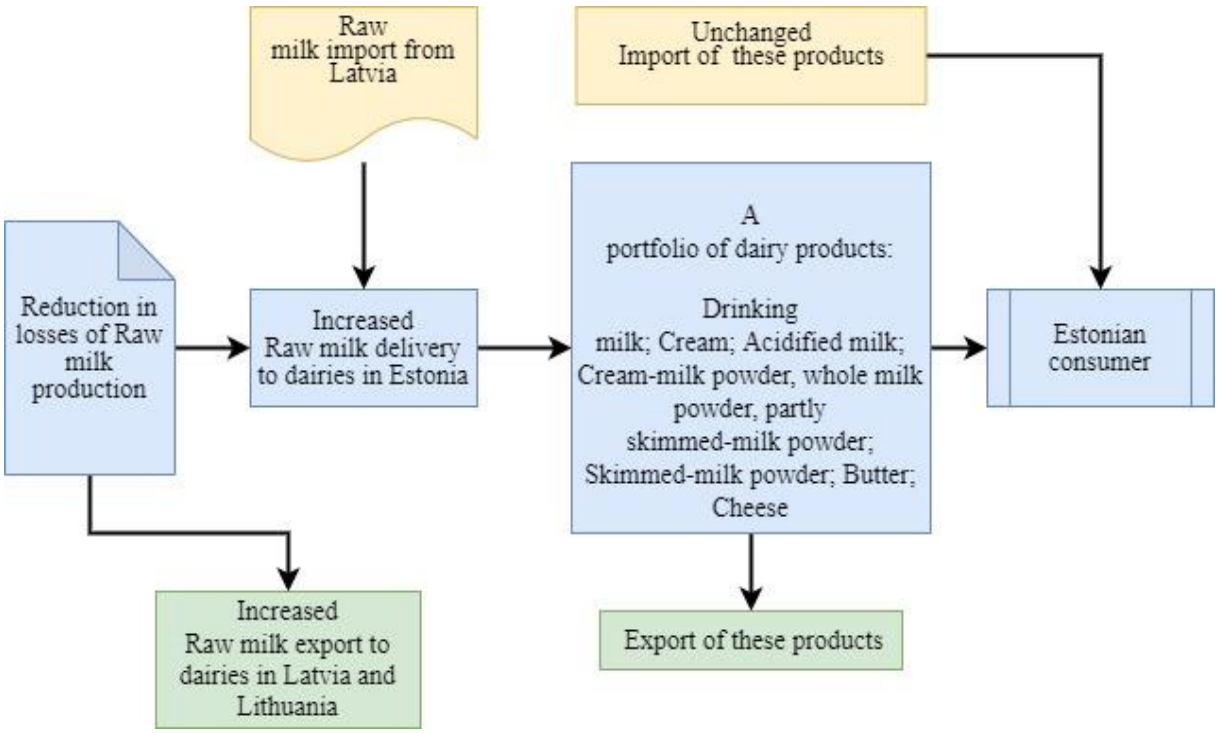

Figure 16. Relationship of reduction in milk losses and trade balance (Author)

Figure 16 establishes a relationship between the milk losses reduction and effects on imports and exports of the milk and milk products. Thereby, by adaptation of improved milking technology, keeping and maintaining the better animal health, timely herd renewal and proper training of staff would partly reduce the losses. Moreover, the available milk that remain unsold could be diverted to fulfill the demand by exports.

Reduced losses in milk production would make it possible to have excess supply of milk available to use by the dairies in Estonia and to meet the export demands of raw milk to Latvia and Lithuanian. Whereas, the imports of raw milk from Latavia might also reduce. Since, the production of milk products by Estonian dairy processing companies would be unaffected because of limited production capacity so increase supply of milk will meet export demand. But the imports of dairy products may remain unchanged because of their non-availability in domestic market.

4.3 Key assumptions

For sake of simplification and logical assessment in accounting methodology, following assumptions have been made;

i. This study is based on selected four commodities (wheat, strawberries, potatoes, milk)
ii. Only realized production of selected commodities have been included for loss estimation. Non- physical losses are excluded.
iii. Absolute losses (both edible and non- edible losses) are not considered, only losses of edible parts are taken into account. Although, this would result in underestimation of such lost amount. Yet, logical to compare with trade figures.
iv. In financial assessment, commodities have different import /export prices for various destinations. Yet market price is considered for accounting purpose. As the prices are fluctuating for all commodities, thereby, average annual prices have been considered.
v. The study assumes, that there is no discrepancy among domestic supply of these commodities and utilization. Therefore, all imports are sold and consumed as well.
vi. Impact of losses on essential imports are kept constant. For instance, domestically produced strawberries accounts for greater cost compared to imported strawberries to processors, involved in value addition. So, such imports are essential and reduction in food losses of this category may not affect such import volume.
vii. All losses are potentially avoidable losses. Therefore, it is assumed that 95% of these losses are avoidable by improving managerial skills, technology and infrastructural changes at farm level.
viii. The food loss rates are representative figures for each category, regardless the differences among food items in the same category.

4.4 Data sources

For this work secondary data has been used that could be divided as;

i. The data required for Food losses is based on the study report “Generation of food waste and food losses in Estonian Agriculture and fisheries” published in January 2021. This data is based on Estonian dairy farmers with at least fifty cows, wheat growers that owns fifty hectares, strawberry growers with 0.5 hectares of cultivated land and potatoes growers with five hectares of land.

ii. Trade data, agriculture production and cultivated land data has been taken from state official database Statistics Estonia, some figures from Eurostat and European Union publications. The cultivated land figures for all four commodities are from Statistics Estonia (PM 0281), wheat production, imports and exports from (PM20), potatoes production, imports and exports from (PM31) while milk figures are taken from (PM178). Import exports figures for Strawberries have been taken from world bank database. For financial estimation, market price of strawberry is based on arithmetic average of consecutive three weeks prices (27^{th} week to 29^{th} week in 2020), while for wheat and potatoes average annual price for year 2020 has been taken from purchased price data published by Estonian Institute of Economic Research. Average selling price of raw milk is from Eurostat for year 2020.

4.5 Accounting methodology

Keeping in view the primary purpose of this work, the methodological approach is based on three main analyses. Each of which will provide the basis for next step to be evaluated. Thus, the fundamental approach to establish a link between the food losses of four commodities (wheat, potatoes, strawberries and milk) and quantity of imports and exports have been initiated by calculated the avoidable losses that are assumed to be 95% at farm level. Following formula will be used to calculate the avoidable losses.

$$\boldsymbol{Avoidable\ losses\ =\ Losses * 95\%} \qquad \textbf{(4.1)}$$

Next, by eliminating these losses would result in additional supply of produce in domestic market. Thus, it is logical to estimate the potentially increased production available to consume in local market. Thereby;

$$\boldsymbol{Potential\ production = Production + Avoidable\ Losses} \qquad \textbf{(4.2)}$$

Here, it is relevant to mention that the milk production figures represent the raw milk sales to Estonian dairies. So avoidable losses are added to these sold quantities to get the potential production estimates.

Since, the losses are not occurred at consumption stages of the supply chain. Hence, avoiding losses will not affect the domestic consumption but only may increase the potential production volume for producer or cultivators. Domestic consumption, thereby, calculated

by following formula except for strawberries where the estimated consumption is around 5000 to 6000 tons.

Domestic consumption = production + imports – exports **(4.3)**

The second analysis is based on the impacts on exports and imports. According to varied nature of commodities, the effect on exports and imports volume of these commodities are entirely different. Hence, there is need to access them separately. For instance, wheat being exported product develop the reasoning that imports of wheat are probably because of specific type of grain demand that does not to produce locally. So, losses reduction and excess supply of wheat would not affect such imports of wheat rather increase the exports only. Thereby, potential exports and percentage improvement in exports will be calculated by using the following formulas

Potential exports = current exports + avoidable losses **(4.4)**

Improvement in exports in percentage = (potential exports – current exports)/ current exports *100 **(4.5)**

The similar logic has been implied in case of and milk. The milk processing companies with certain processing capacity and limited local demand would not respond to the excess supply of milk. Therefore, the available milk will increase the exports of raw milk but not the exports of products.

In case of potatoes and strawberries, avoiding losses at farm level, the available quantity will affect the imports volume, Hence, potential imports and relevant percentage is calculated by using the formulas (4.6) and (4.7).

Potential imports = Current imports – avoidable losses **(4.6)**

Potential imports in percentage = (potential imports - current imports)/ current imports *100 **(4.7)**

The third analysis will provide the financial estimates of gains from exports and savings from imports. The monetary value of existing imports of potatoes and strawberries will be compared with reduced imports monetary value to find the imports savings. Following formulas will be used.

Current imports monetary value = current imports * p **(4.8)**

$$\textit{reduced imports monetary value} = \textit{required imports} * p \quad \textbf{(4.9)}$$

$$\textit{Import's savings} = \textit{current imports monetary value} - \textit{reduced imports monetary value} \quad \textbf{(4.10)}$$

For wheat and milk, monetary value of exports will be compared with the value of expected exports to find the export gains. Following formulas will be used.

$$\textit{Current exports monetary value} = \textit{Current exports} * p \quad \textbf{(4.11)}$$

$$\textit{potential exports value} = \textit{potential exports} * p \quad \textbf{(4.12)}$$

$$\textit{export gains} = \textit{potential exports value} - \textit{Current exports monetary value} \quad \textbf{(4.13)}$$

5 RESULTS AND FINDINGS

Based on the available data, the estimation of avoidable losses at farm level reveals that excluding these losses led to proportional rise in quantity supply of these commodities, at least, in short run for the given time period. Since, around 95% of these losses are (theoretically) avoidable losses. The higher absolute wastes are in wheat cultivation, representing the figure of 39,069 tons while ratio of losses to production is significantly higher in strawberries. The perishable nature and short life span of strawberries have given a rational for these huge wastes. Whereas, the losses to net output ratio for milk is the least in the groups of chosen commodities that is roughly around 3%.

Table 7 First Analysis: Estimation of avoidable losses, potential production and domestic consumption

	Cultivated Area (hectares)	Production (tons)	potential Production (tons)	Domestic consumption (tons)	Imports (tons)	Exports (tons)	Losses (tons)	Avoidable losses (tons)
Wheat	168,038	840,519	877,635	127,787	23,873	736,605	39,069	37115.55
Potatoes	3,639	94,414	121,899	126,945	45,132	12,601	28,932	27485.4
Strawberries	685	1,707	2,522	6,000	3002.99	1228.66	858	815.1
Milk	84,400	763,100	790,699	579,300	13,900	197,700	29,052	27599.4

The second analysis is based on the trade facts of these commodities, the available trade figures clearly separate milk and wheat as export commodities while potatoes and strawberries are imported products for Estonia, establishing the reason to analyze them separately. In practice, the available supply of wheat is not the sole indicator for export rise rather quality of yield determines its flow as exports or animal feed purposes. In presence of Estonian weather conditions, it's hard to predict or even control these quality dimensions of wheat. Yet, assuming this available supply as worth to be exported, the excess available wheat leads to 5% increase in current exports volume.

Table 8 Second analysis (a) calculation of export potential and changes in exports in percentage

	Production (tons)	avoidable losses (tons)	Current exports (tons)	Export potential (tons)	Improvement in exports in percentage
Wheat	840,519	37,116	736,605	773,721	5.04
Milk	763,100	27,600	197,700	225,300	13.96

In contrast to relatively lower losses ratio of milk (3%), the potential improvement in exports is considerably higher that will lead to rise the current exports of milk by approximately 14%. The study results indicate that this sensitivity of exports to losses ratio is significant probably because of given capacity of local processing companies. That assures the additional supply to be exported. The export potential of both commodities has been represented by figure 17.

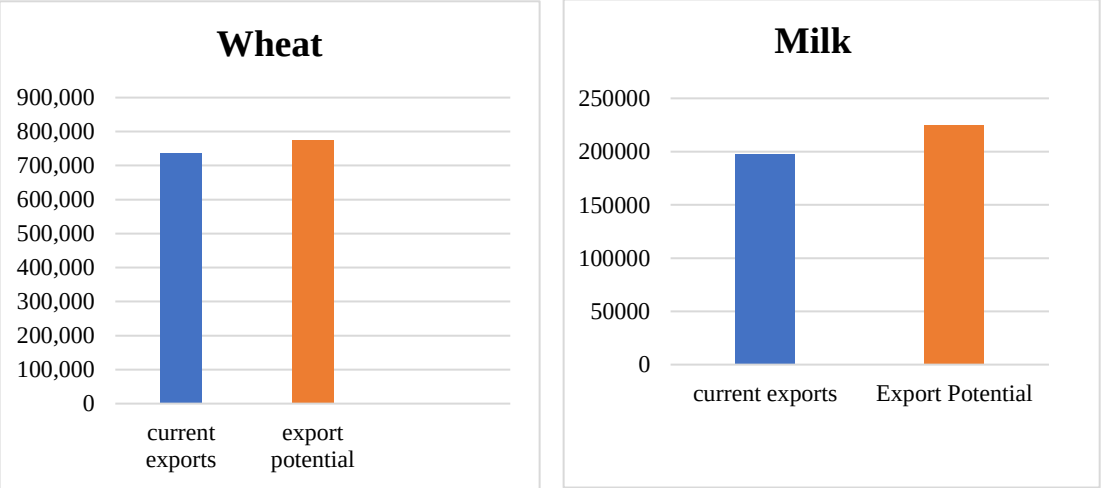

Figure 17. Exports Potential of Wheat and Milk

Table 9 Second analysis (b) changes in import in percentage and absolute quantity

	Production (tons)	Avoidable Losses (tons)	Current Imports (tons)	Reduced Imports (tons)	Reduction in imports in percentage
Potatoes	94,414	27,485	45,132	17646.60	-60.90
Strawberries	1,707	815	3,003	2187.89	-27.14

In general, the losses to output ratio is higher for both imported commodities. potatoes being cheaper product accounts for greater losses perhaps because the cultivator do not find any remarkable incentives to reduce losses at farm level because of lower market returns for produce. On the other hand, the technological advancement required to reduce such wastes, costs more than expected market returns. Nevertheless, excluding losses would contribute exclusively to improve the trade balance for potatoes. In specific, more than half of the potato's imports would possibly be reduced. For strawberries, thereby, 27% of the imports demand is being met by domestically produced strawberries. Figure 18 represents the current and reduced imports for both commodities.

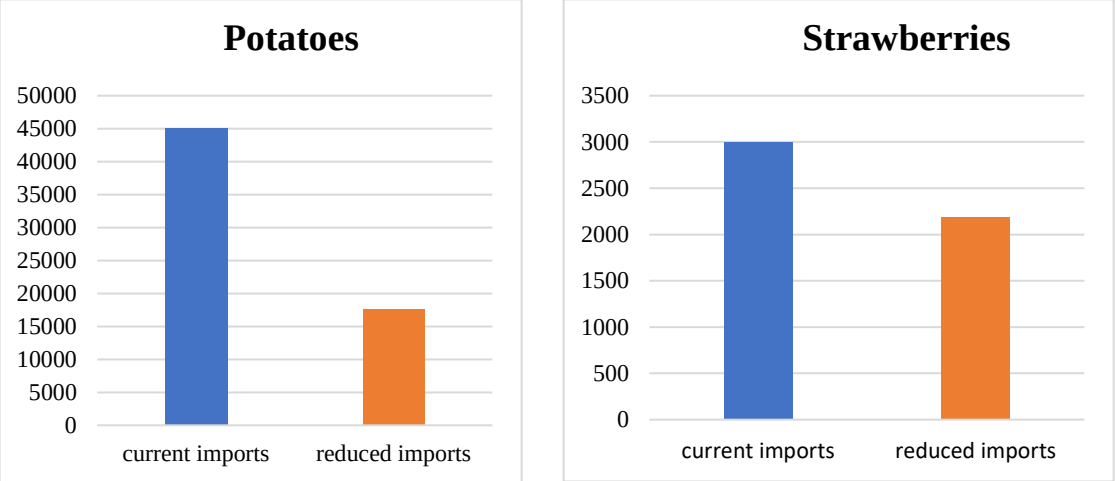

Figure 18. Reduced imports of potatoes and strawberries

Table 10 Third analysis (a) financial assessment of import savings

	Current Imports monetary value (A) EUR	Reduced imports monetary value (B) EUR	Imports' savings (A- B) EUR
Potatoes	7,221,120	2,823,456	4,397,664
Strawberries	5,765,760	4,200,749	1,565,011

The economic damage and lost revenue as the result of food loss has been accessed for all commodities. As discussed earlier, study depicts that 60% imports reduction potential has been accessed in case of potatoes. Despite the lower prices, potatoes imports savings estimated to be around 4.3 million EUR. That is quite significant. Moreover, a point worth mentioning is that all imports could not always considered as a negative term from economic point of view. For instance, some imports are essential because they are cost effective and

after value adding gives more return. Keeping the effects of such import's constant, the strawberries imports savings are estimated to be approximately one and half million EUR.

Table 11 Third analysis (b) financial assessment of export gains

	Current exports monetary value (EUR)	Export potential (EUR)	export gains (EUR)
Wheat	123,602,319	129,830,308	6,227,989
Milk	57,985,410	66,080,343	8,094,933

The results, shows that 3% of milk losses, though least in the group of commodities, yet, would result in considerably higher exports earnings. Around 8 million EUR additionally would be gained by excluding this minimal lost amount from raw milk production. Altogether, only two exported commodities (milk and wheat) worth to be injecting roughly 14 million EUR to Estonian exports earnings.

Table 12. Effect on Agri-food trade balance

Agri-food Trade	Current Trade Balance (Million EUR)	Potential Improvement in Trade Balance (Million EUR)	% Changes
Imports	1507	1501.1	0.39 % decreased
Exports	1174	1188.3	1.21 % increased

The current agri-food trade balance is negative. Excluding losses just on the farm level for commodities (potatoes and strawberries), worth to reduce import payments of approximately 5.9 million euros. That would result to improve the agri-food imports savings by 0.39 %. Similarly, the agri-food export gain will increase by 1.21% by two exported commodities (wheat and milk) that are worth to inject 14.3 million euros. The graphical representation of current trade balance and expected improved trade balance for agri-food is shown by figure 19.

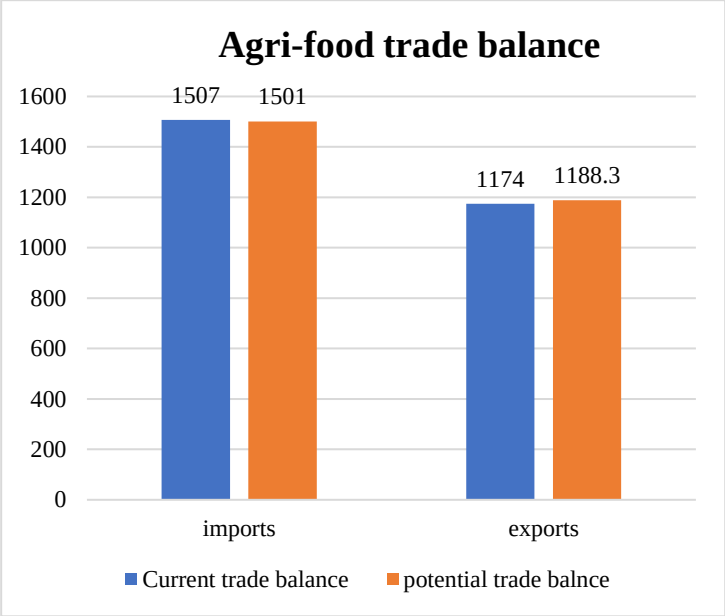

Figure 19. Effect on Agri- Food trade balance

The whole assessment, clearly indicates that the balance of trade for these commodities in specific and balance of trade for agriculture products in general will be sufficiently improve by avoiding these losses only at initial stage of food supply chain.

6. DISCUSSIONS AND CONCLUSIONS

Certainly, the implication of concept of food losses and wastes are more than just the food security. This multifaceted phenomenon caused negative environmental externalities on which the world has been focused so far. But the wider economic impacts have not been investigated with the view of loss of economic value for actors involved in food production and supply chain. The limited literature is being found that is relevant to the monetary costs associated with the lost food amount, for instance Liu, (2014) has associated the food wastes generation with possible treatment options and estimated the monetary returns and savings. Similarly, Chen et al. (2021) has discussed the economic growth with implication of food waste treatment. Yet, its further implications to economic aspects and trade have not been taken into account. Though this study has chosen a relatively narrow approach with respect to whole food supply chain, this only confined to primary agriculture stage. Moreover, the selection of commodities is just limited. yet, the significance of results validates the importance of topic under consideration.

6.1 Economic and trade implications

Exclusion of losses at farm level has implication to enhanced **cost-revenue structure** for the cultivator. In general, considering the farming intensity; input used by the farm per hectares of land (fertilizers, pesticides and other crop protection products) will be saved. The same amount of input will return in greater output per hectare of land. This implies to enhance market orientation and increased competitiveness of farmers because of improved total factor productivity. Certainly, improve **farmers' position in value chain**. Recently, the share of value added for primary producers is lower in favors of food and beverages distribution and services. (European Commission, 2019). The increased return would not just make farmers better off by supplying more but to provide with great opportunity to come up with their own value-added products for increased market returns. The similar view has been supported by Rutten (2013), who argues that tackling the losses incurs the welfare losses on the part of producers who choose to do so in short run but have gains in terms of increased revenue.

A part from financial returns to farmers, the impact of reduction in losses factually could affect the **growth of rural areas** positively. Rural development attributed to farmers' well-being would experience the improved living standards and overall contribute to balanced

territorial development. Although the **rural poverty** rate in Estonia is fluctuating around 26% that is slightly below than EU average poverty rate in rural areas, will considerably be affected and improved. (European Commission, 2019). Convincingly, the financial gains would attract the youth engagement and possible investment in this area. Although, the **employment rate** in rural areas is lower than overall employment rate in Estonia. Local development in rural areas will attract more investments and employment opportunities will enhance.

Currently, Estonia is characterized with agri-food trade that is geographically concentrated. But increased supply by mitigation of losses would enhance this possibility to extend this trade too far off regions, at least for the commodities with more life span. A great opportunity, thereby, could be expected for current agriculture trade to be most favorable in economic accounts of Estonia.

Convincingly, reduction of losses in potatoes cultivation would improve Estonian self-sufficiency in potatoes remarkably. So, for **improved self-sufficiency** of potatoes, may not require enlargement of cultivated area but reduction of losses (by better machinery, more flexible quality standards and also by better storage facilities). Also, for wheat and milk, the effect would be increase in production without increasing variable inputs. But there probably is need to invest into fixed assets to some extent.

6.2 Policy implications

The strategic orientation requires policies and programs at national level. The inclusion and participation of supply chain actors would be crucial in effective implementation of the polices. The institutional role of the government in creation of unified polices, awareness raising and advocacy cannot be denied. Collaboratively made targets and strategies will give a roadmap for target achievements. Unified measurement tools, for instance, food loss index and Food Loss/waste protocol and standards will help analyzing the current situation and future consideration more effectively.

No doubt, improved production planning with mitigation of losses requires that the production acceptance standards to be revised. Thereby, the value of production under EU quality scheme needs to be considered once again, to align with the purpose of food wastes reduction programs.

As far as the policies regarding education and training for improved management practices, latest technological skills enhancement is concerned. The Estonia has quite satisfactory situation compared to EU countries. Almost 40% of total farm mangers attain the basic agriculture training and this trend is gaining momentum (European Commission, 2019). The policy action required the food losses preventive methods to be the part of these training programs.

6.3 Research limitations and future considerations

Additional supply effect local prices: In response to additional supply of commodities in domestic market, the study lacks the fundamental price effects for such commodities in local market. In practice, the economic model of demand supply postulates that, the additional supply pushes the existing prices downward to attain equilibrium. Thereby, the study unable to establish such effect.

Capacity to store: the study has assumed that additional supply, especially in case of strawberries used to fulfill local demand. Presuming the storage facilities enough to respond that excess supply. But reality may not represent such an existence of ideal situation.

Complication factors: several assumptions have been made to make the study simpler and to come to conclusion but some complicating factors may alter the results of study. For instance, the extent to which the food losses could be avoidable might be overestimated. This is highly dependent on the costs involved in different techniques to be implemented for mitigation of losses.

Break even analysis: Losses exclusion at farm level requires the technical improvements and infrastructural changes that comes up with additional costs to cultivators. Surprisingly, the literature and even this study lacks the assessment of such cost comparisons with possible gains. A break-even analysis is must before just considering these gains and their financial effects.

Although this work reflects the greater inconsistencies and financial losses in initial stage of food life cycle, yet, the scope of study is narrow enough to establish the real and absolute possible effects on trade. Hence, it requires the scope of study to broadened to entire food life cycle. Further, Standardization of definition, requires convergence on understanding of the terms of “food losses” and “food wastes”. Greater conceptual clarity requires further research in this area.

6.4 Conclusion

- The synthesis of research results leads to the conclusion that benefits of reducing food losses concentrated in three areas environmental (anthropogenic load on the environment), social (poverty reduction and availability of food) and economic (saving money and resources). The economic aspect of food losses is strongly associated with quantitative assessments of losses and wastes of the entire food life cycle. This in turn necessities a precise and unified approach of measurement of such losses. Further, the terms 'Food losses' and 'food wastes' lacking consensus in exact definitions because of overlaps in fundamental facts that defines these terms. For instance, the higher degree of wasteful behavior that generally define "wastes" could also be observed at initial stage of food life cycle, gives valid reason not to consider these as 'losses' but the 'wastes' only. In absence of such, contrasting views, vague objectives and results have been found in studies.
- Historically, agribusiness sector is commodity oriented with emphasis on maximization of production and economies of scale. Yet, a shift has been seen, following the UN guidelines of food waste reduction by 2030 and European Commission legislation passes on March 2019, requests the member states to make legislation on food waste measurement. Thereby, the food wastes quantification is going on in many European countries including Estonia. The optimal use of available resources is the main idea. In presence of negative agriculture trade balance of Estonia, the issue of food losses worth to be given more attention. Moreover, in Estonia the causes of losses at initial stage of food life cycle validates the common reasons of loss generation that actually observed and accounted at primary agriculture stages in many countries around the world, with few exceptions specific to Estonian case.
- A firm evidence from study results reveals a strong functional relation among reduction in losses of certain commodities (milk, wheat, strawberries and potatoes) and their import export quantities. Link to market transformations, any demand for imports is driven by the availability of that commodity in domestic market. The absence or scarcity of that commodity would end up with increased imports demand. Similarly, excluding losses has many economic results both at micro and macro level, evident from the fact that led to improve the supply of that commodity in domestic market. In view of Estonian case, where limited local demand, unable to absorbs the

increased supply, would direct the additional supply to foreign markets. More likely to change the trade balance of that commodities.

- Convincingly, the effect of reduction in losses has financial implications, not only for growers who could potentially save the input cost, switch to efficient land use and could gain by supplying more in the market but also to the consumers who enjoy the fruits of reduction in losses by more availability and lower market prices. Moreover, for the economy it has dual implications. first, increased self-sufficiency in food supply. Second, injecting more financial gains to economy. The whole assessment, clearly indicates that the balance of trade for these commodities in specific and balance of trade for agriculture products in general will be sufficiently improve by avoiding these losses only at initial stage of food supply chain.
- Predominantly, the management aspects of these losses require the structural assessment, relevant drivers and system pressures to be analyzed. Only in this way the management alternatives could be heighted. The upstream supply chain is less likely to have processing and packaging losses. So infrastructural, technological and managerial skills improvement at farm level could prove to be beneficial. Nevertheless, several hinderance and limitations have been observed in effective implementation of target actions. The financial limitations are most prominent in all.

SUMMARY

The challenge of food security calls for the serious attention on the issue of food losses and wastes for improved biodiversity and economic gains. The inconsistent food loss/wastes definitions and associated measurement methods leads to incomparability in literature analysis. Yet, the researchers generally agreed on the presence of huge inefficiencies along food supply chain. This in turn represents significant economic, environment and social costs. Following the UN goals the EU platform of Food losses and wastes, working in close cooperation with industry consumers and NGOs. The revised EU legislation requires the member states to take action for the food losses reduction. The generic of whole food supply chain, categorizes the whole food supply chain into five distinct stages. Each of which establishes different reasons of losses. Fundamentally, reasons of losses in Estonia at the agriculture stage is quite similar to those reported around the world with few exceptions related to climate conditions and technological applications. The economic assessment of losses has necessary condition of quantification of such lost amount. But, this valuation of losses is on its infant stage in many European countries.

Currently, Estonian agri-food trade balance is negative and represent the regional concentration in trading activities where the neighboring countries are key trading partners. Overall, all agriculture production consumption data represent the Estonian self-sufficiency in food provision to entire population. Yet, the trade data separate the chosen commodities milk and wheat as exported products whereas the strawberries and potatoes are being imported. The study results significantly establishes positive relationship among reduction in losses at the farm level with the trade gains, with several economic, financial, socio-economic implication of this relationship.

Generally, the management of losses requires structural assessment of those drivers and system pressures that triggers and causes those losses. The corresponding management options are very much dependent on their nature that sometimes could be controlled/ uncontrolled and partially controlled.

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APPENDIX

Appendix 1: definition of food losses and wastes

Source	Food wastes	Food Losses
Gustavsson et al.2011	Food wastes represent that part of the food losses, generated at the of food value chain, mainly at retails and final consumption stages. Main causes are wasteful behavior.	Food losses are avoidable, unavoidable and partially avoid able food wastes, occurs at initial stages of the food supply chain.
Aulakh et al. 2013	Food waste is the part of edible food that has been lost due to human actions, more specifically non utilization of food before even the food gets expired or throwing it intentionally without taking any benefit from it.	Food losses, to certain extent are unavoidable wastes that occurs due to managerial limitations of procedures.
Kowalska, 2017	Food waste is behavioral issue that occurs because of negligence or conscious act of throwing food away.	Food losses implies to infrastructural and knowledge improvements, unconscious part of losses is unavoidable generated by system.
Aragie et al,2018	Food wastes occurs at the later stages of food supply chain includes retail and consumption, distribution and households' losses.	Food losses occurs at initial stage of food supply chain, mainly it includes post-harvest, production, primary processing, primary storage and transportation stages of food supply chain.
FAO,2018	This refers to the removal of food from the food supply chain, which is fit for consumption, by choice, or which has been left to spoil or expire as a result of negligence by the actor.	. Food loss is mainly caused by inefficiencies in the food value chains, such as poor infrastructure and logistics, lack of technology, insufficient skills, knowledge and management capacity of value chain actors, and lack of access to markets. In addition, natural disasters play a role

Appendix 2: contextual indicators of Estonia and Estonian agriculture sector in June 2020

Demographic and Economic Facts		
	Figure	Unit
Population (million), 1st January 2019	1,324,820	Million persons
Land Area	45336	km^2
Nominal GDP at current price	28037	
GDP per capita PPP/person	26703	PPS/persons
GDP growth	4.3%	percentage
Agriculture in Economy		
Agriculture shares in GDP (%)	2.2	percentage
Agriculture shares in employment (%)	3.1	percentage
Exports of agriculture products (million euros)	1174	Million euros
Imports of agriculture products (million euros)	1507	Million euros
Share in total exports	5.76 % (1174/20347)	percentage
Share in total imports	7.83 % (1507/19228)	percentage
Characteristics of Agriculture Sector		
Agriculture goods output is, of which;	983.6 million EUR	Million euros
Crop output	50.8%	percentage
Potatoes	2.8%	percentage
Fruits	0.9%	percentage
Animal output, of which;	43.4%	percentage
Milk	25%	percentage

Source: European Commission, Eurostat, and Directorate General for Economic and Financial Affairs, Directorate General for Agriculture and Rural Development.

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